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GUIDE TO CROP PROTECTION IN ALBERTA

PART III
PESTICIDE APPLICATION EQUIPMENT

Alberta
AGRICULTURE

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GUIDE TO

CROP PROTECTION

IN ALBERTA

PART III
PESTICIDE APPLICATION EQUIPMENT

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PART III PESTICIDE APPLICATION EQUIPMENT

CONTENTS

Page

PESTICIDE APPLICATION EQUIPMENT

INTRODUCTION

The use of pesticides requires that all application equipment be of the best quality available and be used correctly.

Incorrectly applied pesticides may result in waste of the pesticide, poor or no control, crop damage or environmental contamination. Every effort must be made to apply pesticides correctly to help eliminate these undesirable results.

Recent advances in equipment technology can make the job of accurate pesticide application relatively simple and precise.

This publication provides information that will aid in the selection and use of application equipment so that pesticides may be applied as accurately as current technology allows.

Since 1981 all pesticides are being supplied and labelled in metric measure. All labels are made in terms of litres of formulated product per hectare or in the case of dry materials, in kilograms of product per hectare.

Alberta Agriculture has decided to maintain land measure in ACRES. This publication lists application volumes as litres or kilograms per ACRE.

This will necessitate converting pesticide label information. The following conversion factor is supplied to assist in this conversion:

Litres or kilograms per hectare x 0.4047 = L or kg per acre.

Alberta Agriculture's "Blue Book" publication GUIDE TO CROP PROTECTION IN ALBERTA — PART I — CHEMICAL SELECTION is written using acres and is compatible for use with this publication without conversion.

SPRAY TIPS

— Know your chemicals: read the labels carefully to determine which is the right one for your crops.
— Know your crops: especially the stage that will tolerate the chemical you use.
— Know your problems: make sure that the weeds and insects you have are susceptible to the chemicals you plan to use.
— Know your timing: if it isn't right for one chemical it may be for another.
— Be prepared to invest in quality equipment: there's no sense spraying with worn out equipment that is worth a fraction of the chemical you are using.
— Pump output should be checked to ensure it produces the required volume for spraying and agitation of the spray solution in the tank.
— Check pressure in the boom to ensure there is no restriction in the flow to the nozzles.
— Ensure all nozzles on the boom are the same size and spray angle.
— Check nozzle spray patterns. Clean or replace nozzle tips that have streaky spray patterns.
— Check the output from all nozzles on the boom using a calibration cup or some other measuring device. Output from the nozzles should be within five per cent of each other.
— Liquid filled pressure gauges will prevent the gauge indicator from fluttering. The gauge will be easier to read accurately and will remain accurate longer.
— Adjust boom height in the field so that the spray pattern from one nozzle overlaps 30 per cent into the pattern of the adjacent nozzle above the target. The target is the ground for soil applied herbicides and the average weed height for post-emergent herbicides.

PROTECTIVE CLOTHING

Everyone who handles pesticides should read the label on the container very carefully, and should wear the standard protective clothing to avoid potential health hazards.

Pesticides include herbicides, insecticides and fungicides, and the standard protective clothing that is recommended is:

— a long-sleeved shirt
— full-length pants
— overalls
— unlined neoprene or rubber gloves
— rubber boots
— a wide-brimmed hat.

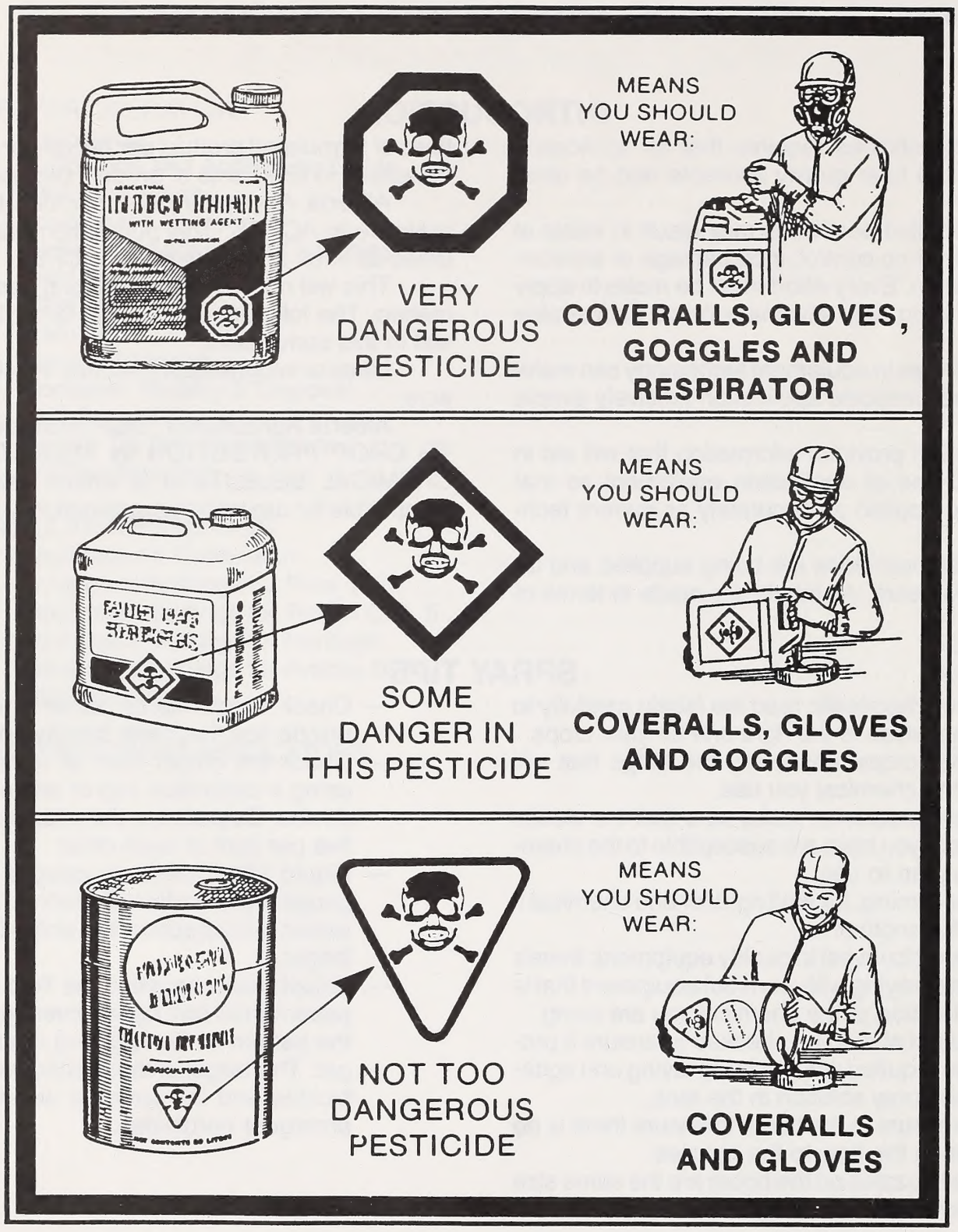
Cloth or leather gloves, leather shoes or sneakers and a baseball cap should never be substituted for the standard protective clothing listed above because they absorb chemicals and will expose the wearer to the chemicals.

In some cases, goggles and a respirator are recommended for people handling pesticides. Goggles, or a face shield, protect the eyes and the face against pesticide vapors, dust and splashes, while a respirator will prevent the inhalation of dust, powders and sprays.

A respirator covers the nose and mouth and contains a charcoal cartridge as well as a filter pad to filter out dust and spray particles. The risk of a health hazard from using pesticides will be greatly reduced if the respirator cartridge is changed after eight hours of use or when the wearer detects a chemical odor.

Anyone who has handled pesticides should shower and change clothing when the operation is finished.

The above information, plus information on laundering pesticide-contaminated clothing, is contained in a publication entitled "Protective Clothing for Use with Pesticides" (Homedex 1353-90). It can be obtained from district home economists or by writing to the Publications Office, Alberta Agriculture, J.G. O'Donoghue Building, 7000 - 113 Street, Edmonton, Alberta, T6H 5T6.



What the pesticide label means

SPRAYER TYPES

More pesticides are applied with sprayers than with any other type of equipment. There are many types and sizes of sprayers. Sprayers can be as small as an aerosol can or as large as a railway tank car. Application volumes vary from a few litres per acre to several hundred litres per acre.

Since the most common sprayer used in Alberta is the low-pressure, broadcast-boom sprayer the major part of this publication deals with it. This sprayer generally has nozzles tips mounted on a wet-boom at 50 centimetre spacings and applies an even swath of pesticide across the width of the boom. Tapered edge flat fan nozzle tips are used on this sprayer almost exclusively and provide a uniform spray pattern when operated at the optimum pressure and height settings.

Sprayers which are used for row crop application have the nozzles mounted on rubber hoses or drop-pipes which are clamped onto a dry-boom. The nozzles can slide along the boom frame to adjust for various row spacings. Row crop sprayers are generally equipped with even-spray fan nozzles which apply even bands of chemical without overlapping from one nozzle to the next as is the case with

the tapered-edge flat fan nozzle mentioned above. For special applications of insecticides or fungicides cone type nozzles are also used with row-crop sprayers.

Boomless sprayers are generally only used for spraying herbicides in pastures, on roadsides and other areas where rough terrain prevents access to a boom sprayer. However, boomless sprayers are also used to apply insecticides in field perimeters and grasslands. Their use in cropland is not recommended owing to inaccurate spray patterns and the drift potential created by the offset nozzles used on boomless sprayers.

Small sprayers, either hand-operated or vehicle mounted are useful for spot treatment in fields, for spraying lawn areas and for spraying in areas that are inaccessible to larger equipment. These sprayers can be used for applying herbicides, insecticides or fungicides.

Mist blowers are almost exclusively used for applying insecticides and fungicides in orchard and vegetable crops, while foggers of various sizes are used for mosquito and fly control either indoors or outdoors.

The sprayers described above are available in numerous models and types and may be mounted on trailers, tractors, trucks, recreational vehicles or may be self-propelled.

Pump up sprayer

Knapsack sprayer

COMPRESSED AIR SPRAYERS

Since many of the operational procedures suggested for the knapsack sprayer also apply to other types, we will first discuss the various hand-held sprayers, then concentrate on the knapsack models.

Nearly all hand-held sprayers are of the manually operated compression type. There are different sizes, shapes and materials, but the principle is the same. An internal or external compression pump is an integral part of the sprayer. Spray can be discharged onto the target for a short period of time before the pressure drops to where the operator must stop and pump it up again.

Most compression sprayers come equipped with an adjustable nozzle that delivers a cone shaped spray pattern and adjusts from a fine spray to a coarse spray and then to a solid stream that may reach three to five metres.

A typical knapsack sprayer can be described as having a tank capacity of eight to twenty litres which is carried on the operator's back. Continuous hand pumping is required to keep the sprayer operating. Knapsack sprayers are not pre-pressurized as in the pump-up sprayer. The pumping action forces the liquid spray mixture out via a small surge chamber. Some of the pressure is retained in the surge chamber, but spray delivery slows down quickly when pumping stops.

By using a knapsack sprayer an operator can handle larger quantities of spray liquid with greater comfort and freedom of movement than with hand-held compressed air sprayers. Thus knapsack sprayers are adapted for larger jobs.

On some models the pump handle can easily be switched from one side of the sprayer to the other. When large areas are being sprayed this minor difference can be a major advantage.

Stainless steel, galvanized steel and brass have been the predominant materials used for sprayer construction. Plastic units have gained popularity more recently due to their corrosion resistance and light weight. Being able to see the liquid level through the plastic sprayer tank is an additional convenience.

Some pesticides, particularly wettable powders, settle out rapidly when added to water. This can pose a problem with hand operated sprayers with no mechanical or hydraulic agitation system. Therefore hand-held or knapsack sprayers must be shaken periodically during use to prevent the chemical from settling in the tank.

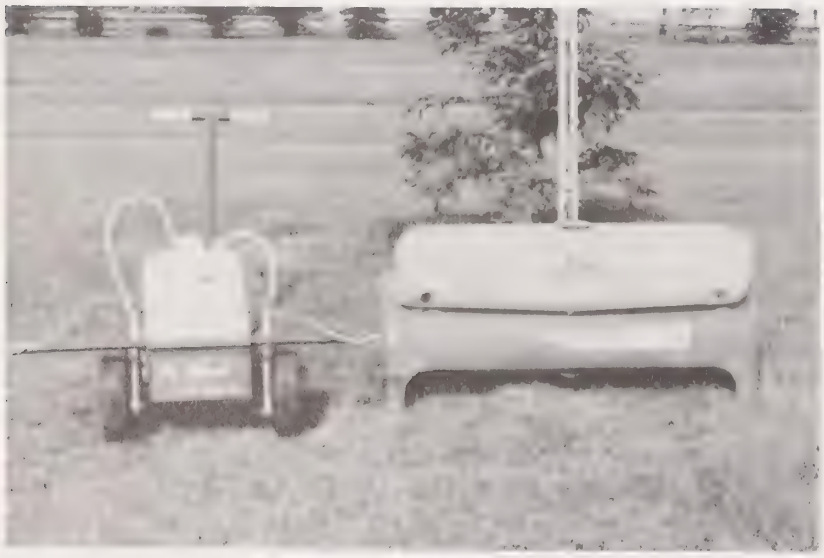
When spraying, the normal pumping and walking action will cause a certain amount of liquid movement in the sprayer. This can be a problem when only a small amount of spray solution is left in the tank. There is still enough liquid to continue spraying but air is introduced into the line. When air is pumped into the line, there is a sputtering of the spray which results in uneven application. This is a signal to refill the sprayer.

A trial with water in the sprayer while spraying a measured area will soon give an indication of how much spray solution is needed to cover a specific area.

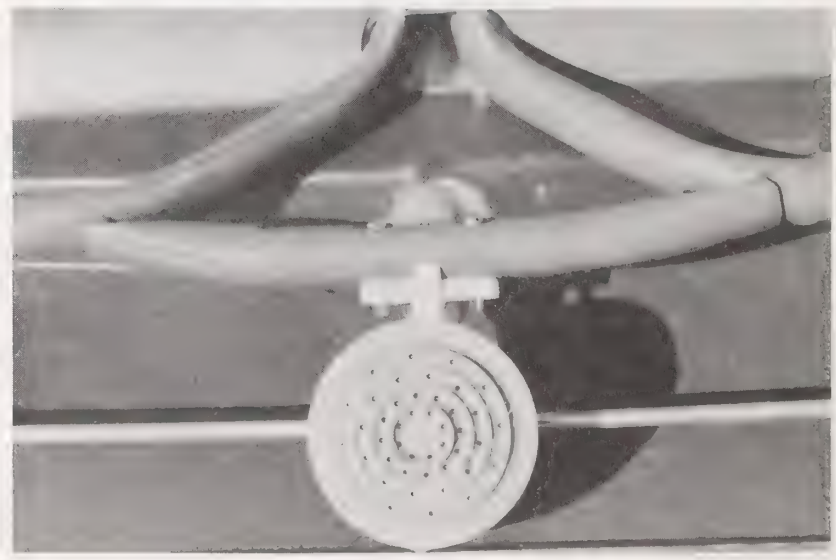
PUSH TYPE SPRAYERS

Push type hand operated sprayers that can be used on large lawn areas are useful for applying herbicides. They usually have a tank capacity of 15 to 25 litres and cover a width of one to two metres.

One type operates on gravity, carrying the spray solution down to a spinning disc. The disc is driven by gears attached to a ground wheel and disperses the spray in a band approximately one metre wide at normal walking speed. The height of the spray disc is not adjustable thereby restricting the use of this sprayer to mowed areas.

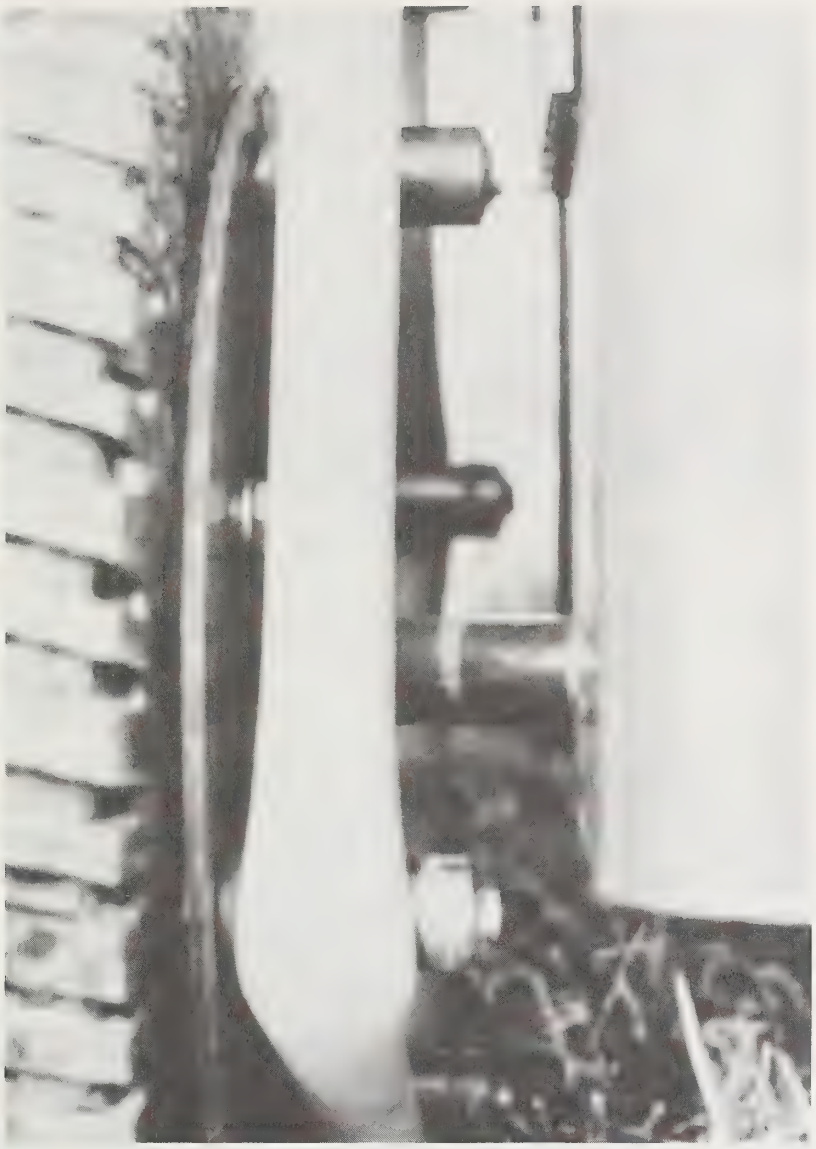


Push type sprayers



Wheel driven disc sprayer

Another model of push type sprayer operates at minimal pressure, which is supplied by a hose pump. The pump is a flexible piece of surgical tubing stretched over a roller reel. The reel is attached to the ground wheel of the sprayer. As each roller revolves it squeezes the tubing creating a vacuum which then fills with the spray solution from the tank. The following roller then squeezes the solution further along the tubing. Adjustment for setting nozzle height is available on this type of sprayer.



Hose pump sprayer

TRIKE MOUNTED SPRAYERS

These sprayers are equipped with a 12 volt electric pump connected to a tractor battery or the ATV battery. The pump requires only 5 amps to operate and delivers about 4.5 litres per minute at 200 kPa pressure. They can be equipped with a short boom and a handgun for spraying weeds or for spraying trees for insect control.

CAUTION: As there is no agitation system in this type of sprayer, do not use wettable powder formulations of pesticides unless agitation can be provided.

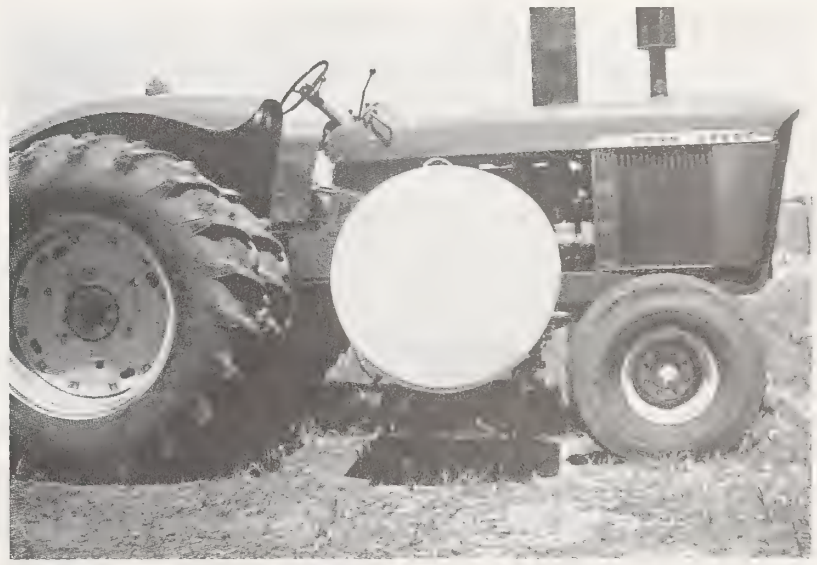
Trike sprayer

Three point hitch sprayer

TRACTOR MOUNTED SPRAYERS

Tanks on tractor mounted sprayers usually hold from 500-2000 litres and can be mounted in several positions on the tractor. The pump can be attached directly to the PTO shaft, or may be driven by a hydraulic motor. Booms may be mounted in the front, rear, or belly positions. Broadcast applications may also be made with a nozzle cluster. This boomless type of application may be used in pasture spraying. Tractor mounted units are combined with other equipment such as planters, cultivators or tillage implements.

The tractor-mounted concept is occasionally used for mounting sprayers on swathers, however, large tanks are not used as the frames are unable to support heavy weights.

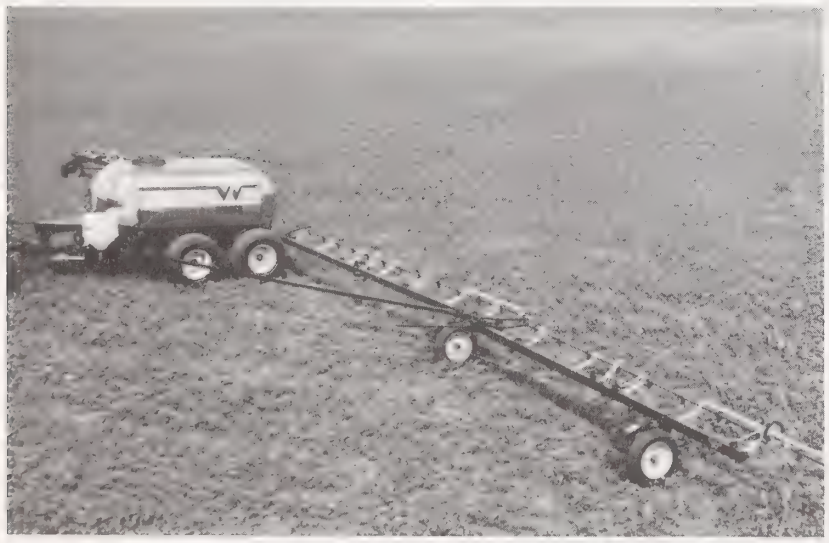


Side mount tank

Row crop sprayer

HIGH CLEARANCE SPRAYERS

High clearance sprayers have evolved from tractor-mounted sprayers and are used for spraying row crops. The tank is underslung and fits between crop rows. The spray boom is raised or lowered depending on crop height and application requirements. An adjustable rear axle allows spraying in a wide variety of row spacings and wheel shields help prevent the wheels from damaging low hanging crops.

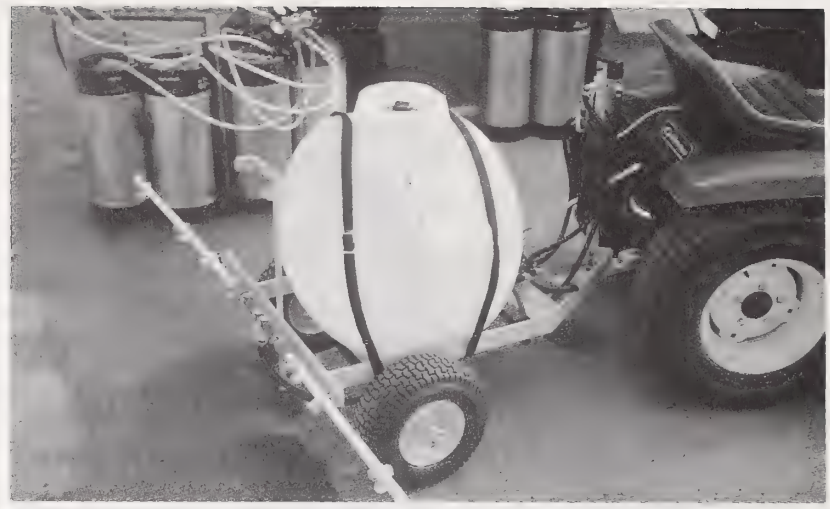


Field sprayer

TRAILER MOUNTED SPRAYERS

The most common type of sprayers used by farmers in Western Canada, trailer-mounted sprayers, are designed to be towed through the field by a tractor. Tank capacity can be as large as 4000 litres with boom lengths up to 24 metres or more. Pumps are mounted on the tractor or sprayer and are driven by the tractor PTO or a hydraulic motor. These sprayers are used to apply most pesticides in cereal and oilseed crops as overall broadcast sprayers. In most cases the nozzles are permanently set at 50 cm spacing in a wet boom.

A variety of small trailer-mounted sprayers are commonly used by acreage owners, industrial institutions and by farmers with large lawn areas. These sprayers come equipped with either a 12 volt electric pump or a PTO pump. Handguns can be adapted to allow spraying of trees for insect control.



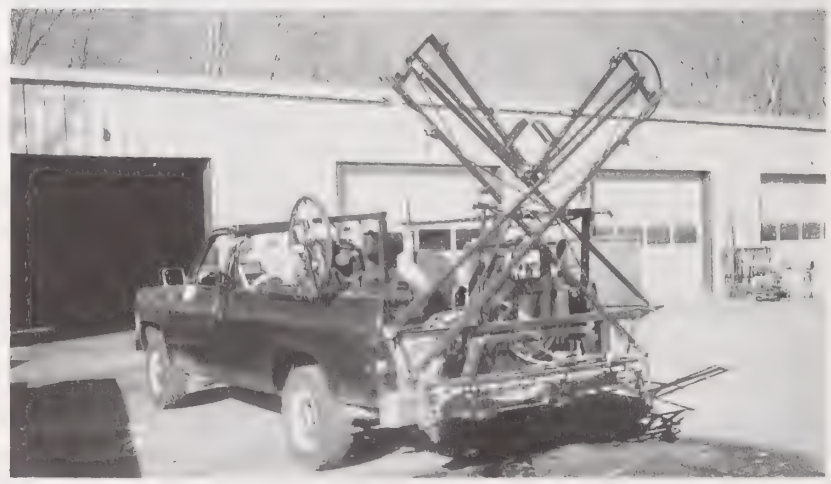
Estate sprayer

TRUCK MOUNTED SPRAYERS

Sprayers on skids may be mounted in a pick-up or flat-bed truck. Pump power is supplied by an auxiliary engine. Tank size depends on the size of the truck used to carry the sprayer. Attachable booms are available for use in crop spraying. These booms can be detached and the sprayer can be used for pasture spraying, roadside spraying or for any number of industrial situations where it is too rough to use the field size booms.

Removable boom sprayer

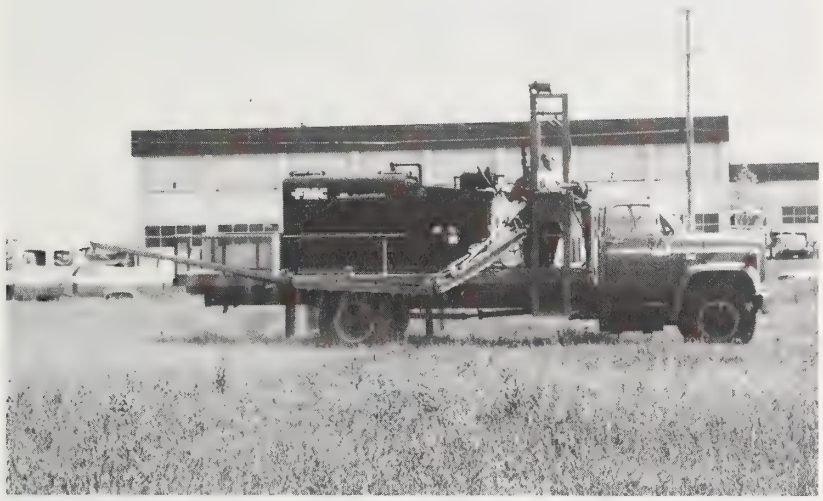
Some models of truck mounted sprayers have a built-in boom that folds up when not in use for crop spraying. Some form of boomless system can be employed when spraying in areas where there are too many obstacles to use booms.



Folding boom sprayer

Larger sized sprayers mounted on large trucks are generally used for roadside spraying for brush and weed control or for spraying other rights of way such as pipelines and power lines. These sprayers are generally equipped with a piston or diaphragm pump which can develop substantially higher pressures for use with a handgun. However, excessive pressure only increases drift potential and is not generally recommended for applying herbicides.

A variety of hydraulic booms are used by municipalities for roadside spraying. Some districts use o.c. nozzles or accutrol nozzles as a boomless type of spraying system. The boomless systems are less costly than hydraulic articulating booms however the spray distribution is not as uniform; the spray swath is limited and boomless systems are more prone to create drift (refer to nozzle section and boom section).



Hydraulic boom

Boomless sprayer

SELF-PROPELLED SPRAYERS

Large self-propelled sprayers have floatation tires. These tires cause less severe crop damage than normal width tires and allow operation under wetter soil conditions. Due to their initial cost "floaters" are best suited for large farmers or custom operations. Some units have a tank capacity up to 10,000 litres. Dust created by the large tires has resulted in poor weed control with some post-emergent herbicides therefore excessive speeds should be avoided for these operations.

Floater

Smaller self-propelled sprayers, such as the one shown below, have been used for a number of years by Alberta farmers with varying degrees of success. Potential for drift has been lessened by having height adjustment for the boom installed in newer models. These sprayers have high clearance and adjustable wheel width thus allowing for spraying of insecticides and fungicides in later crop stages as well as making them useful for row crop spraying.

Small S.P. sprayer

Aircraft sprayer

AIRCRAFT SPRAYERS

The principal advantages of aircraft sprayers compared to ground equipment are:

- application can be made in places and at times when ground equipment cannot operate
- speed of application will save time
- elimination of soil compaction and crop damage
- no capital investment required by the farmer.

Among the disadvantages to be considered are:

- drift hazard is greater
- not applicable to small fields
- unless properly calibrated and operated, aircraft sprayers are not as thorough in applying herbicides as ground rigs.

Helicopters are more maneuverable than fixed-wing aircraft and are not restricted to operating from a landing strip. However, they are more costly to use than fixed-wing units and have a smaller payload.

Pesticides are applied in either a water or oil carrier, depending upon the chemical make-up of the herbicide.

The label must be consulted for recommendations on rate, addition of an adjuvant, water volume and whether or not the product is registered for aerial application.

Mist blower for tree spraying

MIST BLOWERS

Initially, the most common method of spraying fruit trees was with the use of a high pressure sprayer unit and one or more handguns.

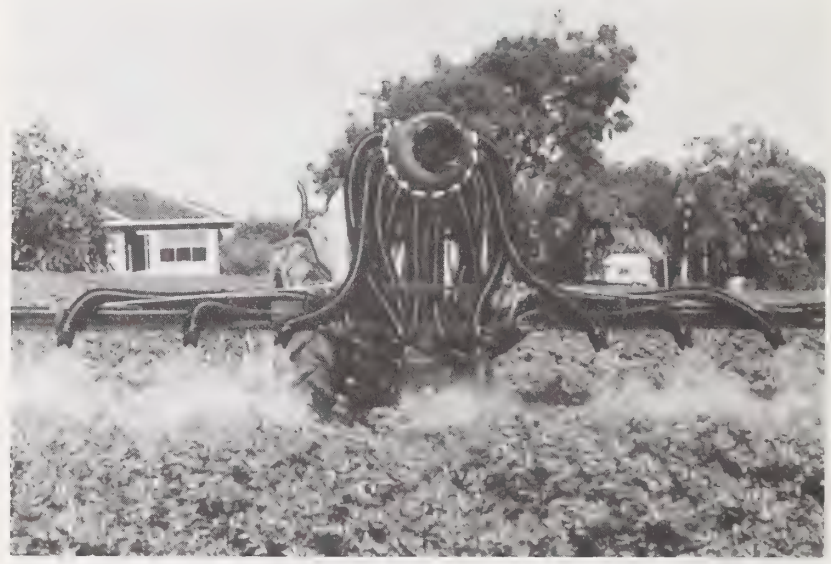
The continual increase in chemical costs along with the market's demand for improved quality of orchard produce created a need for cost effective chemical application. Since that time, the use of a mist blower sprayer has been extended to many other types of crops. Today you find mist blowers in grapes, raspberries, blueberries, hops, date palms, evergreen trees and various types of vegetable farms.

A mist blower can be defined as an air carrier. It uses air as a carrier for the spraying of liquid. Combining air and water as a carrier for the chemicals allows for a higher concentration of spray material which means more acreage will be covered per tank.

Generally, hollow cone nozzles are commonly used on mist blowers. The size of nozzle will provide the correct volume and the type of swirl plate will create the droplet size in conjunction with pressure.

To get 100 per cent coverage, you must replace all the air in the leaf mass with spray loaded air. This same principle applies to the spraying of trees, bushes or vegetables. Another factor to consider is the density of the crop you are spraying. This, together with the weight of the leaves and thickness of the stem, will determine the speed and volume of air necessary for good penetration. This can change between two different varieties of apples, for example, and with their stage of development in the season.

Another fact to consider, especially when it comes to spraying grapes, berry bushes and vegetables, is the bouncing effect the air can have on a very dense leaf mass. Since all crops try to expose the leaf surface to the sun, it can sometimes be hard to get thorough penetration. Some sprayers are equipped with adjustable outlet spouts. Best results have been reached by adjusting these spouts 30° - 45° backwards from the direction of travel. One important factor for good penetration is the forward speed of the equipment. A rule of thumb is never drive faster than 7 km when spraying with a mist blower.



Adjustable spouts

Lightweight portable foggers that can be used indoors or outdoors to dispense chemicals for mosquito and fly control are available in various price ranges. These units are also used for abating noxious odors.

Portable fogger

Motorized knapsack sprayers can be used for liquid spraying and for applying dusts or granules. Some manufacturers offer kits which allow motorized knapsack sprayers to be used for fogging for insect pest control.

Motorized knapsack

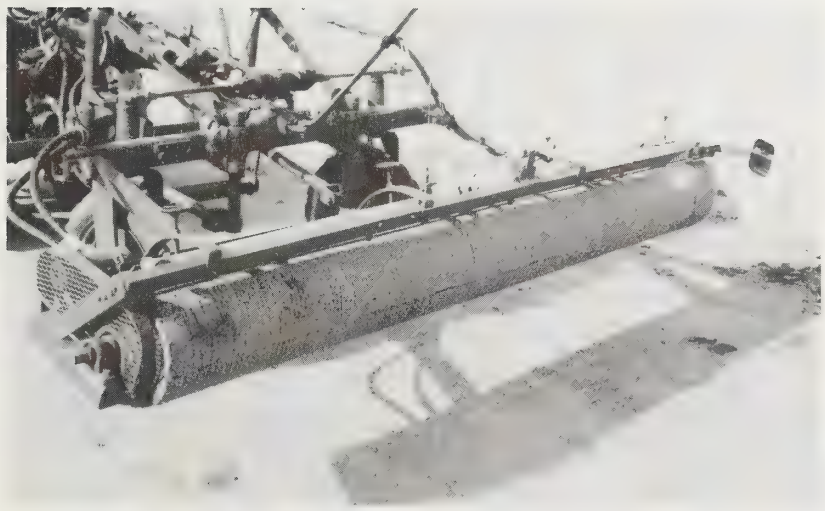
WIPER APPLICATORS

A weed control technique being researched and tried on a limited scale is the use of height-selective applicators. This weed control equipment relies on a height difference between the crop and the weed to achieve selective control. Generally, the weeds must be at least 15 cm above the crop. Several types of applicators are available.

These types of applicators may have a use in row crop situations and other areas where tall growing weeds affect crop production.

Roller Applicator

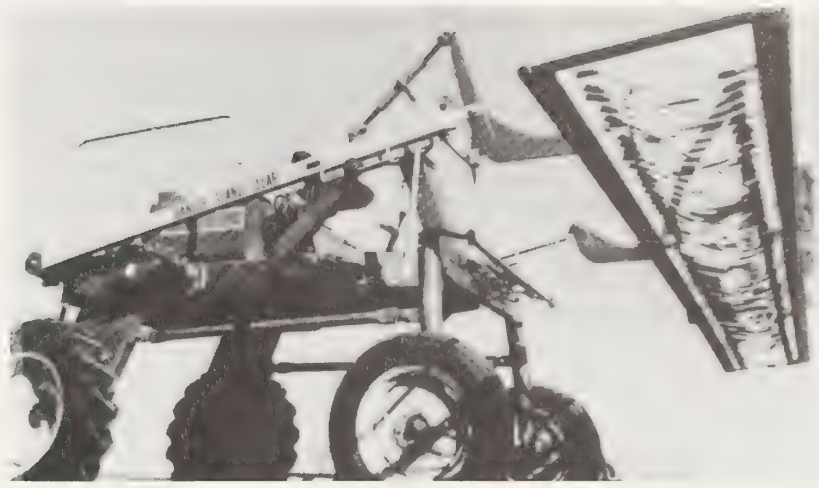
This unit has a rotating roller which is carried above the crop. A herbicide is applied to the roller and is wiped onto the weed growth above the crop.



Roller

Rope-Wick Applicator

This machine operates similarly to a roller applicator. However, the roller is replaced by a pipe which holds the herbicide and is fitted with pieces of rope which are wetted with herbicide through capillary action. The rope wipes the herbicide onto the weeds growing above the crop. Rope-wick applicators can be homemade or purchased commercially.



Rope-wick

Hand Held Wipers

Hand held wipers are generally constructed of a plastic pipe shaped like a hockey stick with a rope or ropes mounted on the blade portion. The rope is connected into the pipe to allow chemical solution (in the pipe) to wick through the rope to be wiped onto the vegetation.

This type of weed wiper was designed for the home and garden situation to treat smaller areas and remove unwanted growth near desirable vegetation. The herbicide will control only those emerged plants that are directly contacted by adequate amounts of solution. Repeat treatments will be necessary to control vegetation that was not contacted or did not receive sufficient contact during the initial treatment.

Hand held wiper

All of these systems have advantages and disadvantages.

Advantages:

- Selectivity can be achieved using non-selective control methods such as non-selective herbicides.
- Smaller quantities of herbicides are applied on a per acre basis, reducing chemical use, cost, and soil residues.

Disadvantages:

- The level of control is less than with conventional spraying. Low growing weeds are not controlled.
- Some weeds are not controlled even if adequately contacted.
- Weeds are controlled later in the season, after considerable competition has taken place.
- New equipment is required.
- Travel over advanced crop may cause trampling.

Height-selective applicators will likely develop as a supplement to current weed control methods and will be

used primarily to clean up weeds which have escaped control and to control patch infestations of perennial weeds. Row crops which allow later season traffic without trampling the crop, and control of weeds in forage crops may be other areas where height selective applicators will be useful.

SPRAYER COMPONENTS

Sprayers and other application equipment have three basic functions to perform:

1. Storing chemicals during field application.
2. Metering the quantity of material being applied.
3. Distributing the material accurately in the desired pattern.

To perform these functions sprayers have numerous components which can be arranged in many ways. For a particular situation, the best combination depends on:

— the chemical being applied
— the crop being treated
— the application rate
— the required accuracy.

TANKS

Sprayer tanks are available in a variety of shapes, sizes and materials. Square tanks and tanks with flat bottoms should be avoided as proper agitation and cleaning are difficult. The most popular shapes are the oval tank and the cylindrical tank. They both have good agitation and cleaning characteristics.

Tank sizes should be proportional to sprayer boom width and intended application volumes. Sprayers with a boom 15 metres or wider should have a minimum tank size of 1400 litres. With an application rate of 40 litres per acre travelling at a speed of 8 kilometres per hour and a boom width of 15 metres, a 1400 litre tank would cover 35 acres in just over one hour.

A smaller tank would require more frequent refilling, reducing field efficiency. Larger tanks reduce the number of refilling stops, but require that special attention be paid to the undercarriage to prevent excessive crop damage.

The tank must have a conveniently located, large opening for filling, cleaning and inspecting. An opening of 30-45 centimetres is usually sufficient. The opening should be splash-proof and fitted with a large 80 or 100 mesh screen. The lid should be vented and leak proof. This will help to keep the outside of the tank clean and free from corrosion and pesticide which can contaminate the operator.

The drain hole must be located in the tank bottom to facilitate thorough draining. A liquid level gauge complete with capacity markings is a must.

Tanks are available in galvanized steel, stainless steel, aluminum, fibreglass and polyethylene. Mild steel is not recommended as it corrodes readily, requiring considerable maintenance.

The above mentioned materials are resistant to most chemical corrosion, however, the operator must check the chemical label for instructions and precautions.

Galvanized Steel Tanks

These tanks are inexpensive and are made in a variety of shapes and sizes. They are easily repaired or modified. The biggest drawback is corrosion. Even with protective coatings, chemicals cause rapid rusting. Rust flakes off, plugs nozzles, clogs strainers and damages pumps. Galvanized tanks are suitable for most pesticides but they should not be used with the more corrosive liquid fertilizers.

Stainless Steel Tanks

Stainless steel is the highest quality material for pesticide applicator tanks. It is strong and resistant to corrosion by crop chemicals. Since it is the most expensive material used for sprayer tanks, only equipment with high yearly use is equipped with it.

Aluminum Tanks

Aluminum tanks are medium in cost, resistant to corrosion and are suitable for many chemicals. However, they should not be used for liquid nitrogen solutions. Lab tests have shown that the herbicide TCA has some chemical reaction with aluminum, however, if the tank is cleaned immediately after use no problems should arise.

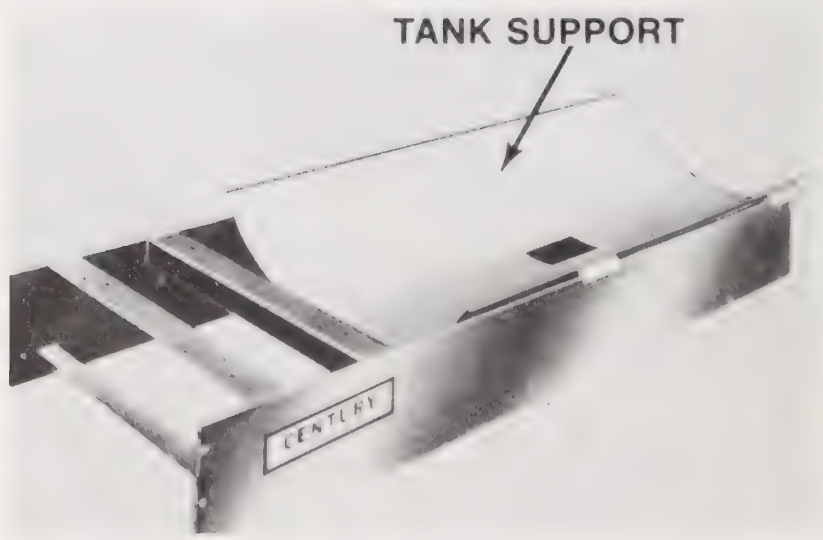
Fibreglass Tanks

Fibreglass tanks are widely used on all types of sprayers and as nurse tanks. Fibreglass is strong and durable, however, it will crack or break under sharp impact. "On farm" repair kits are available for minor problems. The cost of fibreglass is about equal to that of aluminum. Some types of solvents may affect fibreglass tanks.

Polyethylene Tanks

Polyethylene tanks are relatively inexpensive and can be made in many sizes and shapes. They are resistant to corrosion and can be used with all pesticides and with most fertilizers except ammonium phosphate solutions. Polyethylene tanks are tough and durable, however, if one is cracked or broken it must be replaced as there is no effective way to repair it. Since polyethylene breaks down under ultra-violet light tanks should be stored inside when not in use.

Polyethylene and fibreglass tanks must be properly mounted on a "saddle" which supports the tank over a large area. Without it, the weight of the liquid in the tank may damage the tank as the sprayer bounces over rough terrain.



Tank saddle

UNDERCARRIAGE

The undercarriage of a sprayer not only carries the weight of the tank and contents, but also provides the main support for the booms.

Sprayers with large tanks should have enough wheels to provide a level of floatation which will prevent crop damage. The tandem axle or walking beam axle arrangement is preferred. With the wheels following in the same track, compaction and crop damage may be kept to a minimum. The walking beam axle provides a smooth steady support for the booms, maintaining a more even height above the target.

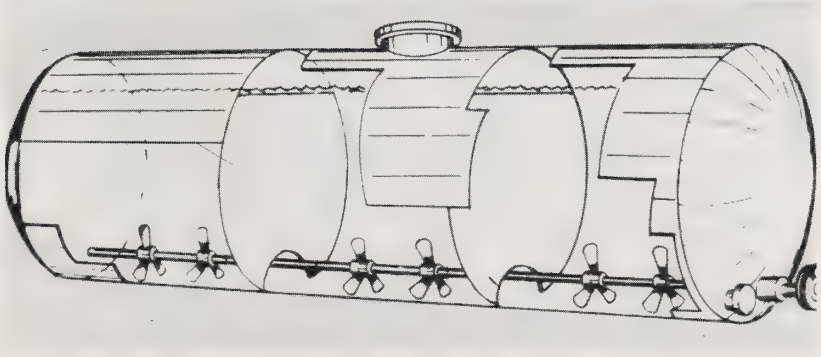
On many of the larger sprayers, both the booms and the trailers are equipped with either floatation tires or tandem wheels. Prairie Agricultural Machinery Institute (PAMI) tests have indicated these are effective in reducing compaction and boom movement, but many farmers are concerned about crop losses from trampling. Trampling from spraying amounts to less than 2 per cent and usually much of the crop recovers. About half of the trampling is caused by the tractor; the only additional loss is from the boom wheels. Thus, sprayers (regardless of design) cause little loss in addition to that caused by the tractor itself.

Walking beam axle

AGITATION SYSTEMS

Intense agitation is required to keep some chemicals in suspension. The return flow from the pressure regulator does not normally provide enough agitation, especially when the pump output drops off. To ensure adequate agitation for all chemicals, a mechanical, or jet agitator should be used in the tank. A jet agitator is probably easier to install in most existing sprayers, although mechanical agitators provide the most positive mixing. Sparge tube agitators may also be used.

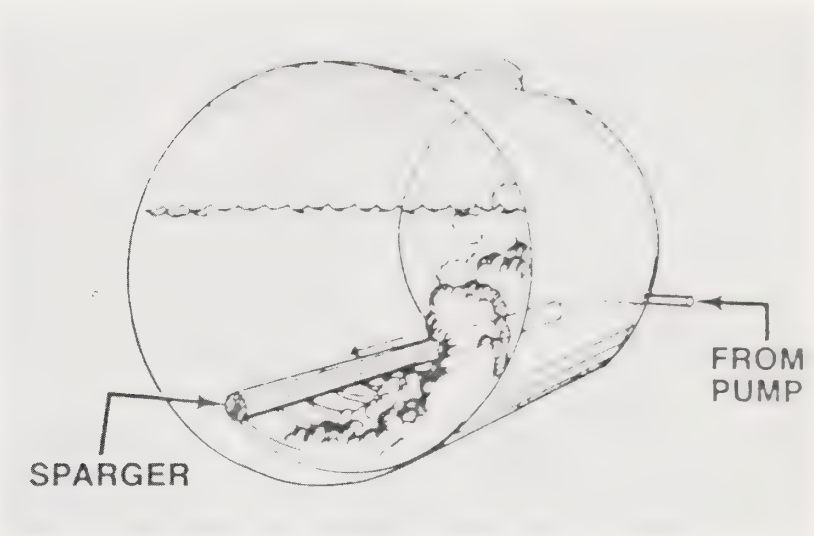
Using only the by-pass return liquid to provide agitation is often inadequate even with full pump output, and as the output decreases the amount of return liquid decreases, thus providing less agitation. No indication of low pump output is given with this system until the return liquid drops to zero.



Mechanical agitator

Mechanical Agitation

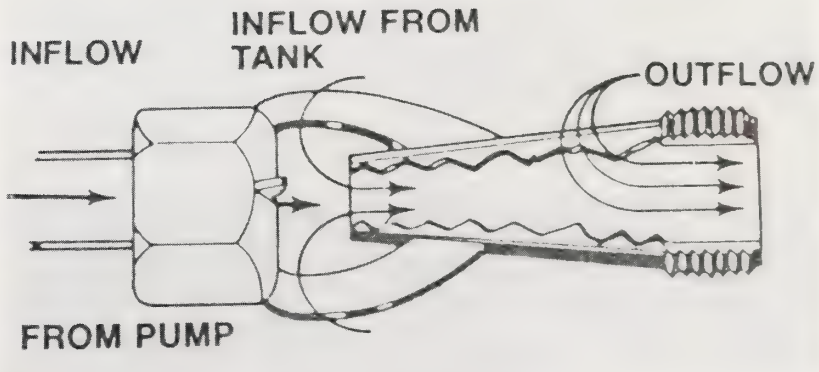
Mechanical agitation can be provided by paddle wheels or propellers driven by electric motors or power shafts from the tractor. Mechanical agitation provides the most positive and thorough mixing possible but the systems are expensive and require a high degree of maintenance. The added expense and complications make them impractical for most farm-type sprayers but they are common on commercial, high pressure, utility sprayers.



Sparge tube

Sparge Tube Agitation

Sparge tubes consist of a perforated pipe or pipes running the length of the tank. The pipe is connected to a pressure line and liquid pumped through it sweeps the bottom of the tank. These devices must not be connected to the bypass since excessive pressure would build up when the booms are turned off. Although sparge tubes do not increase the quantity of liquid in circulation, they do provide uniform agitation throughout the tank.



Jet agitator

Jet Agitation

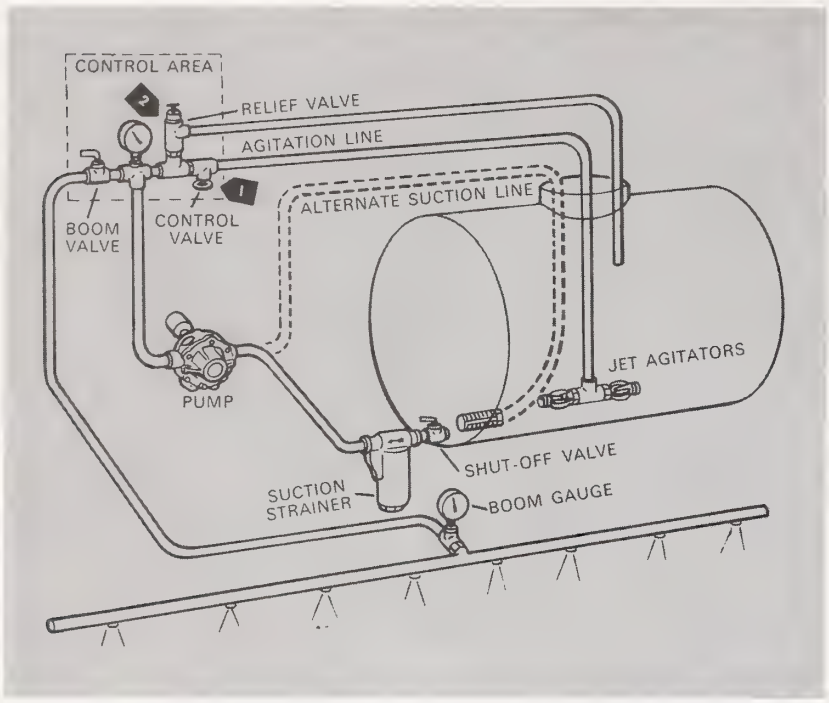
Jet agitators with venturi caps have an output of two or three times their input. Various sizes are available for different sizes and shapes of tanks. A per minute input of about one to two per cent of the tank capacity is recommended.

In order to get adequate mixing of wettable powders, several nozzles are required to get a complete sweep of the

tank bottom. Large flat bottom tanks need more nozzles than do round tanks.

Jet agitators must NEVER be connected to the return line from the pressure regulator as excessive pressure will occur when spray lines are shut off.

Jet agitators must be securely fastened inside the tank to prevent whipping. A throttling valve should be provided in the agitator line to reduce the flow if excess foaming occurs.



Hookup for jet agitator

To adjust for spraying, first close the agitator control valve and open the boom valve. Adjust the relief valve until the pressure gauge reads 75 to 100 kPa above the desired spraying pressure. Slowly open the agitator control valve until spraying pressure is reached. If the pressure won't come down even with the control valve wide open, use a larger orifice in the agitator.

PUMP PERFORMANCE

A variety of pumps can be used on sprayers. Each kind has certain capabilities and limitations that determine when it should be used.

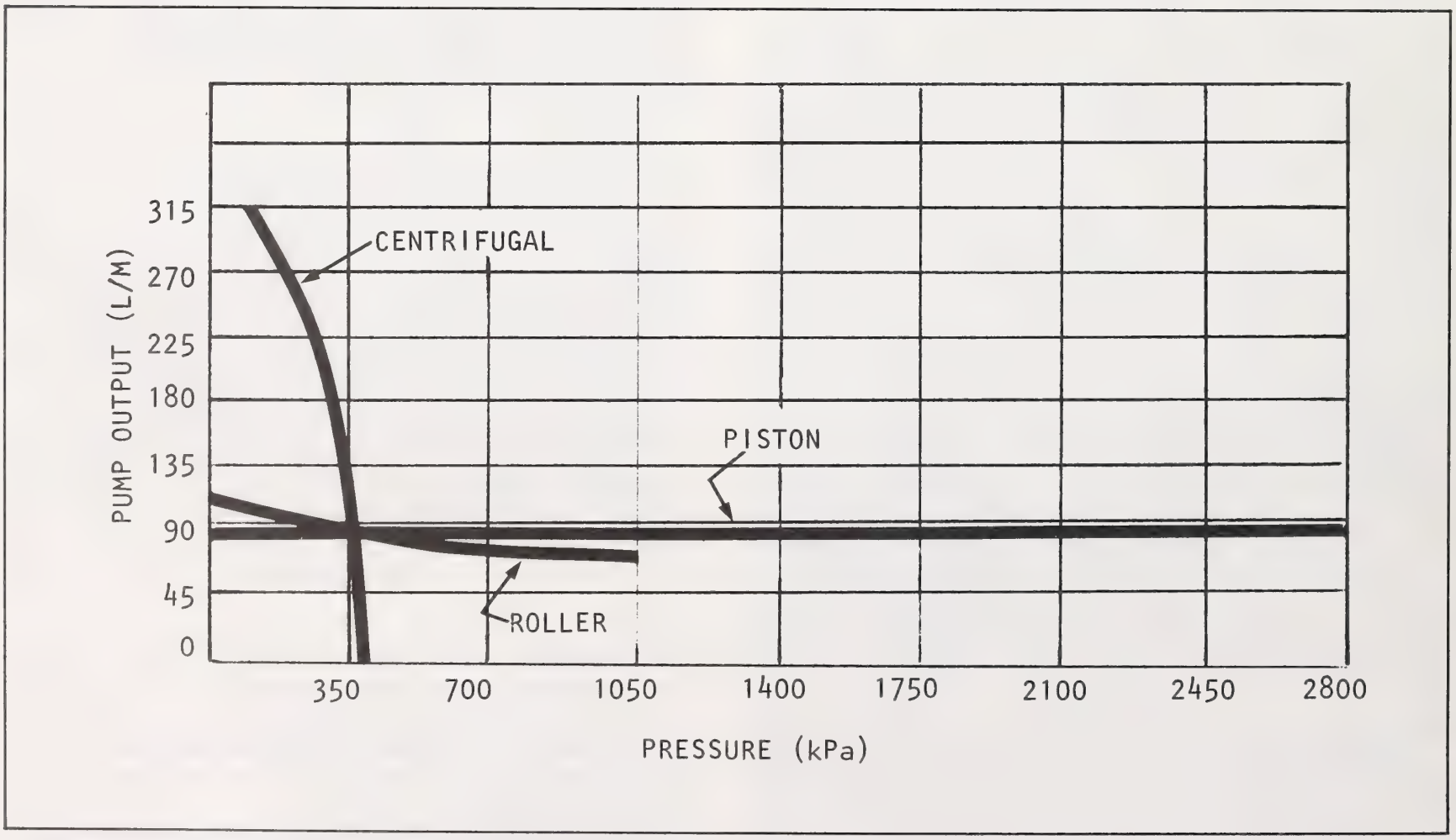
The roller, and centrifugal pumps are the most common types employed on agricultural sprayers.

The roller pump affords relatively low cost, easy upkeep and efficient operation at tractor pto speeds. However, roller pumps tend to wear from continuous use and need replacement. Abrasive material will cause extensive wear in roller pumps. The advantage of centrifugal pumps is that abrasives can be used with them. These pumps can deliver high volume at relatively low pressure in continuous duty operations.

Pump Capacity Check

- Disconnect hose leading from pressure side of pump.
- Attain required rpm.
- Direct pump flow into a container for one minute.
- 'Measure the amount collected and compare with manufacturer's output specifications.

A worn pump is indicated if spraying pressure can not be achieved with boom valves open at the correct rpm.



Pump performance curves

Pump and Plumbing Sizes

Sprayer			Pump Size (L/min)	Plumbing Sizes (I.D. mm)						
Boom Width (m)	Tank (L)	(L/ac)	10 km/h	Pump Ports Inlet	Pump Ports Outlet	Boom Line	Boom Pipe	Bypass Line	Agitator Line	Filter Ports
10	680	40	34	20	20	13	20	13	13	25
	900	40	38	25	20	13	20	13	13	25
12	900	40	42	25	20	20	25	13	13	25
	1130	40	46	25	20	20	25	13	13	25
	1350	40	50	25	20	20	25	13	13	25
15	1130	40	53	25	20	20	25	25	13	25
	1350	40	57	25	25	20	25	20	13	25
	1800	40	65	25	25	20	25	20	20	25
18	1350	40	63	25	25	20	32	20	20	25
	1800	40	72	25	25	20	32	25	20	25
	2270	40	80	25	25	20	32	25	20	25
24	1850	40	85	32	25	20	32	25	20	32
	2270	40	93	32	25	20	32	25	20	32

PUMP AND PLUMBING SIZES

Pumping requirements on a farm sprayer are modest. Pressure is relatively low and volumes required are usually under 100 litres per minute. Nevertheless, adequate pump capacity is a must for proper sprayer functioning. Pump capacity is determined by the following factors:

- rate of application per acre
- width of the sprayer
- speed of travel
- size of tank (agitation requirement).

The table indicates the pumping capacity required for various sprayer sizes. Consideration has been made for agitation requirements and an allowance added for normal wear.

When selecting a pump be sure that its capacity is rated at the pressure you will be operating at. Some manufacturers rate their pumps at zero back pressure and of course this capacity is greater than at 275 kPa.

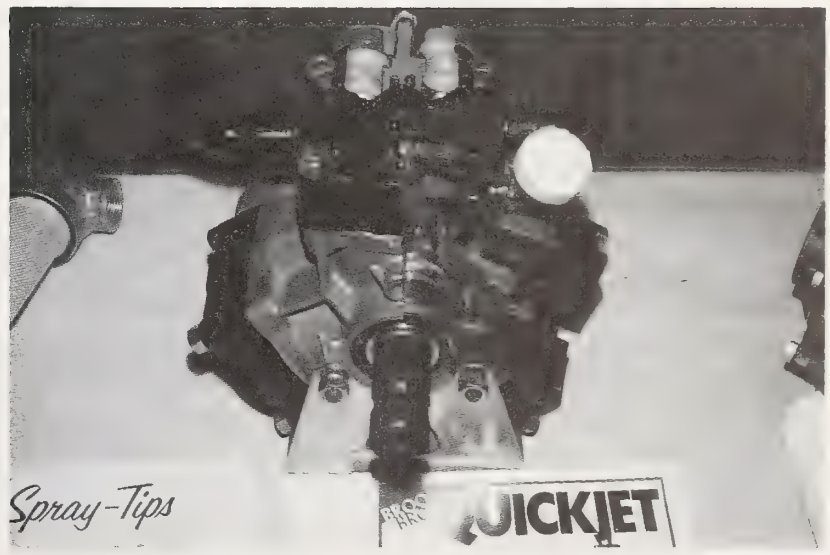
DIAPHRAGM PUMPS

The pumping action in a diaphragm pump is produced by the movement of a flexible diaphragm. Liquid is drawn into one chamber on the downstroke and forced out of another on the upstroke. The diaphragm is resistant to wear by abrasives but may be attacked by certain chemicals.

High volume, high pressure, diaphragm pumps are being used on industrial sprayers with success. Plumbing a diaphragm pump into a sprayer is the same as for a piston pump.

Preparation:

(a) Ensure oil level is at least halfway up oil reservoir. (Hardi Pumps are grease lubricated, so oil is not used.)
(b) Suction lines must be secure and free of air leaks. Sucking air into the system seriously reduces efficiency and can cause chemical to foam.
(c) With at least one boom section open, run the pump for one or two minutes at zero pressure to evacuate all air.
(d) Never exceed recommended rpm.
(e) Ensure plumbing is of adequate size, especially the input side. Also check that there are no restrictions in the line.



Diaphragm pump

Maintenance:

(a) Clean the pump after use by running clean water through for a few minutes. Finish with the suction line out of the water to empty the pump.
(b) Check oil level and if necessary top up with a good 20W/30 oil. If oil changes color, or disappears completely, refer to Problem Solving section.
(c) Change oil every 200 hours, or at the end of the season, whichever is soonest. To drain, remove oil filter plug, normally located at base of the pump body. Rotate the shaft by hand until oil stops flowing. Slowly refill with oil, rotating the shaft by hand at the same time, until the level is halfway up the reservoir.
(d) Replace all diaphragms, valves and 'O' Ring seals at the end of each season.
(e) Completely drain pump for winter storage — especially the manifolds. Protect from frost.

Problems and Causes	Remedy
Pump does not suck. One or more valves damaged or not seating properly.	Check valves and clean valve seats.
Suction filter blocked or restriction on suction side.	Clean filter and check for restrictions in suction line.
Pressure gauge fluctuates badly. Nozzles "spitting". Pump not completely evacuated of air, or is sucking air.	Check suction hose and couplings for air leaks. Rotate pump with outlet taps open, until nozzles stop "spitting".
Pump pulsates and so does pressure gauge needle. Incorrect air pressure in air receiver.	Starting at zero, progressively pressurize air receiver, with pump running until pulsations cease (normally between 25% and 33% of operating pressure).
Water pumped at little or no pressure. Pressure regulator faulty or of insufficient capacity.	Check and repair or replace.
Pump has insufficient capacity for nozzles fitted.	Check flow rates on nozzle chart x number of nozzles. Check chemical recommendations to see if smaller jets may be used. Adjust speed/pressure accordingly.
Output drops and pump becomes noisy. Oil level too low.	Top up with multigrade oil to correct level.
Oil changes color. One or more leaking diaphragms allowing chemical to mix with oil.	Check diaphragms and valves. Drain oil. Refill with oil.
Oil disappears and comes out of discharge pipe. One or more diaphragms split.	Drain pump of oil. Dismantle heads and check diaphragms and valves (remember a broken valve can fall into the cylinder and split the diaphragm). Fit new diaphragms. Refill with oil.
Oil level drops steadily and persistently. Shaft oil seal leaking.	Strip pump and fit new oil seal.

ROLLER PUMPS

Roller pumps are commonly used because of their low cost and compact size. They operate at 540 and 1,000 rpm, they are easily repaired and have adequate capacity for field sprayers. Roller pumps can be used to pump plain water and other pesticide solutions including wettable powders. The roller material should be compatible with the solution being pumped. Always check manufacturer's information on pump use.

The rollers of a roller pump fit into slots of a rotating hub. The slots allow the rollers to follow the eccentric shape of the housing. As the rollers pass the inlet port, the space between rollers and the housing becomes larger and draws fluid into the pump. The fluid remains between two rollers as it moves to the outlet port. As the rollers near the outlet port, the spaces become smaller and the fluid is expelled from the pump.

Roller pump

The output from a roller pump decreases substantially as the operating pressure increases because the rollers tend to let more fluid leak back between rollers.

Preparation:

- Rotate shaft by hand to ensure pump has not seized.
- Ensure pump is securely coupled.
- Suction lines must be secure and free of air leaks. Sucking air into the system seriously reduces efficiency and can cause chemical to foam.
- With at least one boom section open, run the pump for one or two minutes at zero pressure to evacuate all air.
- Never exceed recommended rpm.
- Ensure plumbing is of adequate bore size - especially on the inlet side. Also check that there are no restrictions in the line.

Maintenance:

- Always flush pump thoroughly with lubricating oil after use.
- Test the pump at the end of each season by running it at 275 kPa pressure and checking that the flow is sufficient for maximum sprayer application required.
- Examine condition of rollers. If reduced in size, or worn to a 'conical' configuration, pump should be reconditioned or replaced.
- To recondition the pump, replace all rollers and seals. Take great care in correctly locating seals on reassembly. If shaft is badly worn, it should be replaced. This can be difficult, and purchase of a new pump should be considered. If the inside of the pump body is worn or corroded, a new pump should be purchased.

It is normally not possible to satisfactorily recondition a roller pump more than once.

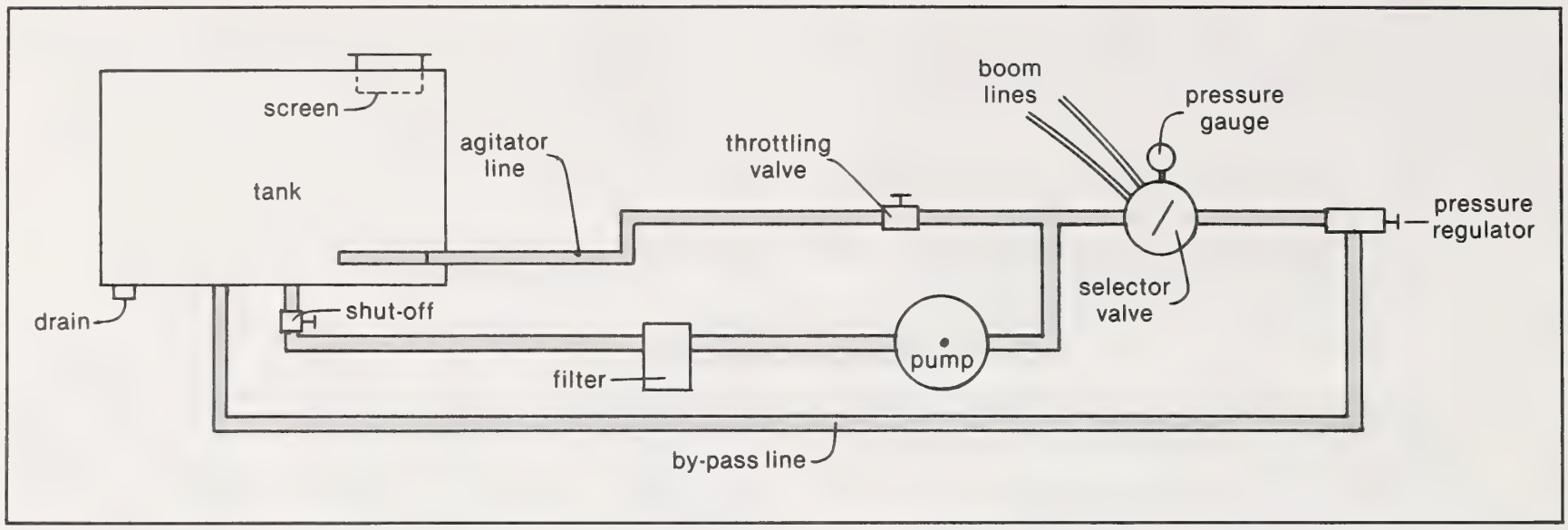
Capacities Of Common Roller Pumps

Pump	Max. rpm	Output (volume)
Hypro 7560	1000	42 L/min @ 540 rpm & 345 kPa
Hypro 7700	900	47 L/min @ 540 rpm & 345 kPa
Hypro 1700	600	77 L/min @ 540 rpm & 345 kPa
Hypro 1500	800	114 L/min @ 540 rpm & 345 kPa
Hypro 6300	1200	57 L/min @ 1000 rpm & 345 kPa
Hypro 7560	1000	82 L/min @ 1000 rpm & 345 kPa
Hypro 1700	1000	164 L/min @ 1000 rpm & 345 kPa
Delavan 66-3000	850	32 L/min @ 550 rpm & 345 kPa
Delavan 6-0000	1000	35 L/min @ 550 rpm & 345 kPa
Delavan 77-3000	850	45 L/min @ 550 rpm & 345 kPa
Delavan 7-0000	850	50 L/min @ 550 rpm & 345 kPa
Delavan 7-3110HS	1000	58 L/min @ 1000 rpm & 345 kPa
Delavan 7-4110HS	1000	58 L/min @ 1000 rpm & 345 kPa

Roller Pump Hookup

A general hookup of a roller pump for spraying appears on the next page. Agitation is accomplished by a hydraulic or jet agitator, using part of the output from the pump to create an increased liquid flow to keep the material from settling out. The relief valve protects the system and is used in setting spraying pressure.

Problems and Causes	Remedy
Pump does not suck. Rollers worn out.	Replace rollers and seals or replace pump.
Air entering inlet side of pump.	Check inlet coupling and plumbing for leaks. Rotate pump with outlet taps open.
Suction filter blocked.	Clean suction filter.
Pump becomes noisy. Pump starved.	Check inlet plumbing for restrictions.
Rollers worn out.	Replace rollers and seals, or replace pump.
Inside of pump body badly worn or corroded.	Replace pump.
Running too fast creating cavitation.	Slow down PTO speed.
Pressure and output drop. Rollers worn out and/or inside of pump body worn or corroded.	As for above.
Restriction in line.	Check inlet and outlet and rectify.
Nozzles spitting. Air leaks on inlet side.	Check inlet/suction hose and couplings for air leaks. Ensure all washers and seals correctly positioned.



Roller pump hookup

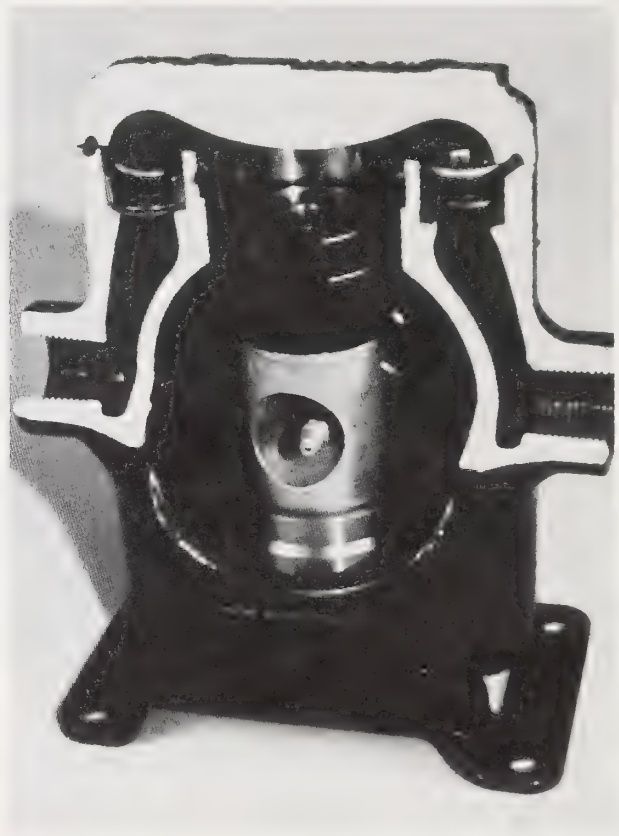
PISTON PUMPS

These pumps are primarily designed for high-pressure spraying applications. Piston pumps are positive displacement pumps, which means that output is proportional to speed and virtually independent of pressure. They are a good pump for wettable powder suspensions and other abrasive liquids. These pumps are suitable for use on field sprayers but are not commonly used owing to their high purchase price. However they are one of the best types of pumps for custom operators or on any utility sprayers.

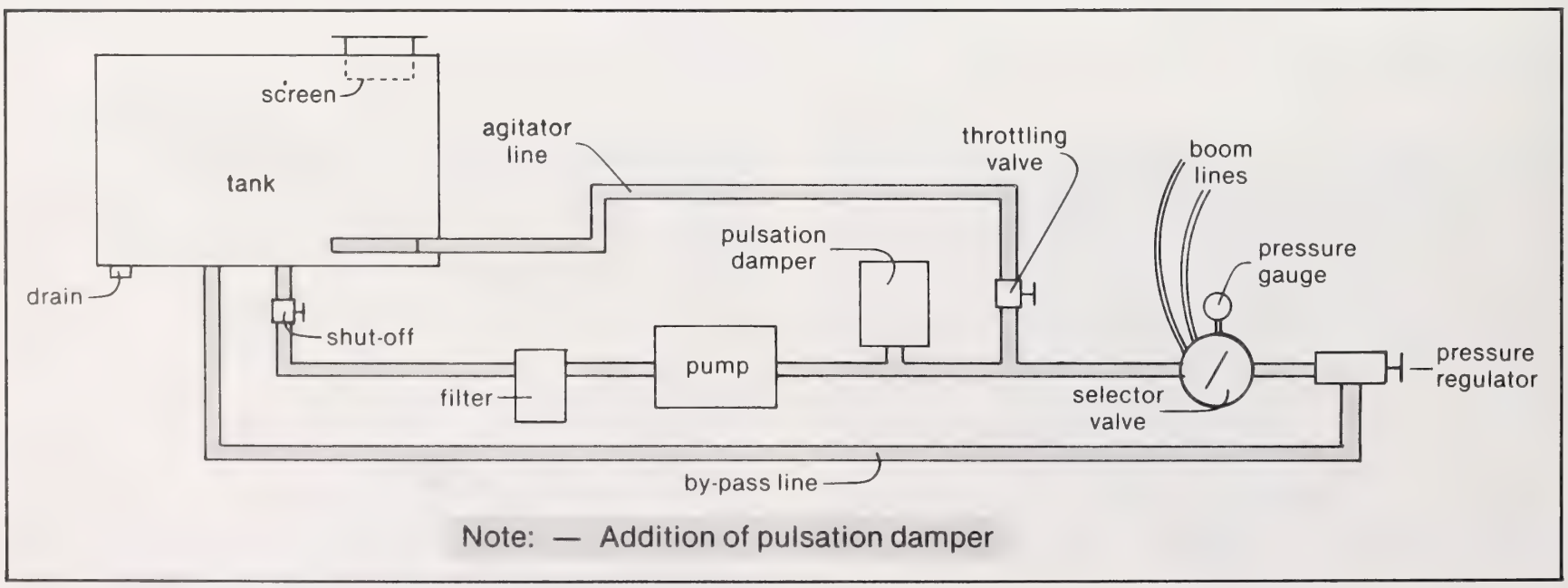
Piston Pump Hookup

The connection for a piston pump is similar to that for a roller pump except that a surge tank has been introduced at the pump outlet. This accessory reduces the line pulsation that is characteristic of piston pumps.

In spraying applications where pressures well below 1400 kPa are usually adequate, the system may be connected with a standard relief valve in place of the unloader valve as in the diagram for roller pumps. When pressures over 1400 kPa are used, the relief valve should be replaced by an unloader valve. This decreases the pressure on the pump and the load on the engine or motor when the spray gun or boom valve is closed.



Piston Pump

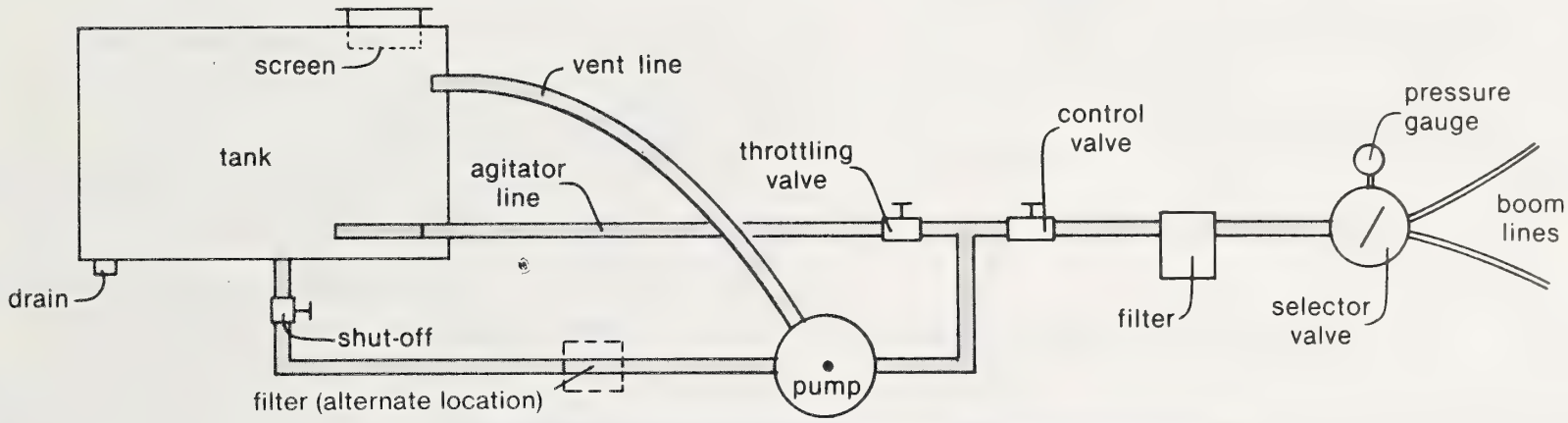


Piston pump hookup

CENTRIFUGAL PUMPS

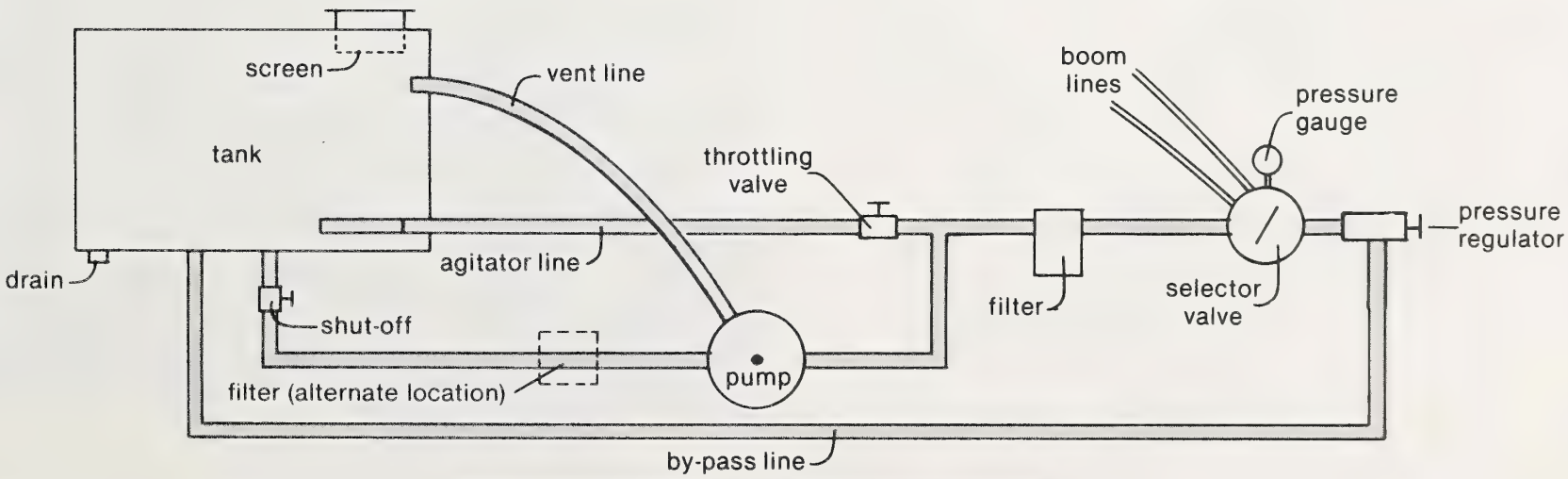
Centrifugal pumps have become increasingly popular as they handle abrasive materials well, and have a high capacity to provide adequate hydraulic agitation. Centrifugal pumps must be driven at high speed to develop pressure by belt, gear, or hydraulic drives. Pump output falls off rapidly after 300 kPa pressure. The centrifugal pump's main disadvantage is that pump output decreases rapidly with small reductions in pump speed. Turbine pumps have similar characteristics to the centrifugal pumps but run at a lower rpm.

Centrifugal pump



Note: — Location of filter
— No pressure regulator; uses control valve
— Positive inlet pressure required

Centrifugal pump hookup — No P.R. Valve (see page 19)



Note: — Hook-up similar to roller pump
— Positive inlet pressure required
— Desired method of hook-up

Centrifugal pump hookup — c/w P.R. Valve (see page 19)

Troubleshooting Hydraulic Driven Centrifugal Pumps

Problem	Causes and Remedies
1. Pump doesn't deliver flow	a. Suction strainer clogged: clean strainer. b. Loss of prime: install sump or anti-vortex fitting in tank. — make sure discharge end of bypass or agitation line positioned below liquid level in tank — run a vent line from top most vent plug in pump volute to spray tank to bleed off air — check suction plumbing for leaks. c. Collapsed suction hose: replace with wire-reinforced hose and increase hose size if undersized. d. Impeller stuck or clogged: remove volute and check for foreign object and rotate impeller. e. Too much suction lift: reduce amount of suction lift.
2. Liquid leaking at juncture of centrifugal pump and hydraulic motor	a. Pump seal leaking: follow pump disassembly instruction and replace face seal. b. Motor seal leaking: follow pump and hydraulic motor disassembly instructions and replace seal.
3. Lack of pressure developed by centrifugal pump	a. Insufficient motor speed on "open-centre" hydraulic systems: adjust motor speed (On Deere "closed-centre" systems inadequate motor speed should not be a problem when using orifice.) b. Excessive restriction on discharge side: increase discharge hose and fittings up to recommended size, check for clogged line strainer or pump capacity may be exceeded.
4. Inability to reduce pressure to desired spraying range	a. Excessive motor speed on "open-centre" hydraulic systems: adjust motor speed (On Deere "closed-centre" systems excessive speed should not be a problem when using metering orifice.) b. Bypass or agitator plumbing too restrictive: Increase size of hose and place pressure gauge as near to spray nozzles as practical.
5. Hydraulic fluid becomes too hot	a. Clogged oil filters or dirty oil: replace hydraulic oil and filters at recommended intervals. b. Improper system maintenance: keep hydraulic oil at proper level, clean dirt from system, keep relief valves adjusted properly and check for dented or kinked lines. c. Incorrect application of hydraulic motor: check tractor specifications.
6. Hydraulic motor operates in an erratic manner	a. System trouble: check system for air or fluid leaks. Check fluid for proper quantity and viscosity. b. Motor wear: inspect motor for excessive wear caused by impurities in system. Replace if necessary. c. Hydraulic hose quick-couplers not transferring oil from tractor hydraulic system: be sure coupler ends are clean and locked together in the operating position.

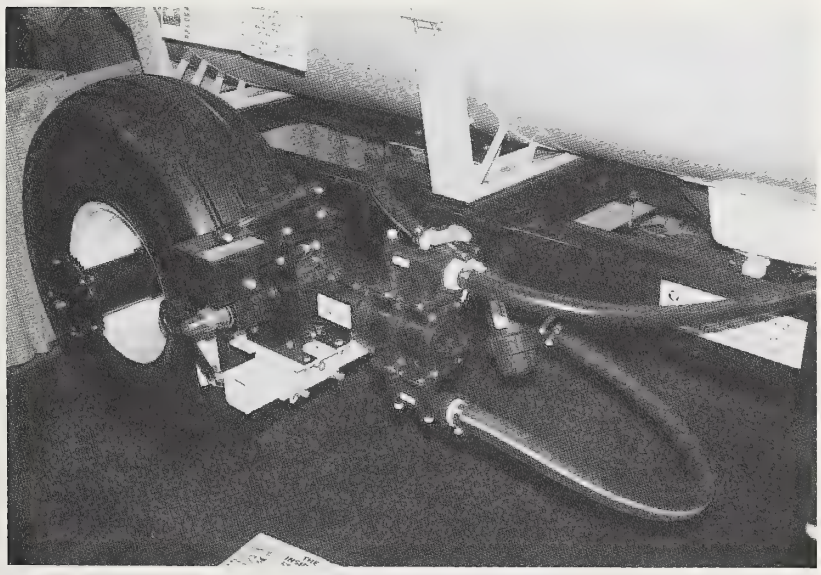
Centrifugal Pump Hookup

- A small plastic vent tube leads from the top drain opening in the pump housing back to the tank. This positive vent line allows the pump to prime itself by bleeding off trapped air when the pump is not operating. The small stream of liquid that flows back to the tank when the pump is operating is negligible.
- No relief valve is used.
- Inasmuch as the primary purpose of the line strainer is to prevent clogging of the spray nozzles, it is shown in the line to the boom or spray gun. A small strainer is adequate in this position as much of the pump output is recirculated. Alternate locations are in the suction line, if its capacity is adequate for the pump, or at the pump outlet, if it is also sturdy enough to withstand full pump pressure. In either of these locations it will help to clean the tank by straining out sediment as the solution circulates.
- Two flow control valves are used — one in the agitation line and one in the line leading to the boom — with shut-off valve — or spray gun. This permits control of agitation flow independently of nozzle flow.

Maintenance Instructions:

When the unit is not to be used for an extended period of time, follow these instructions:

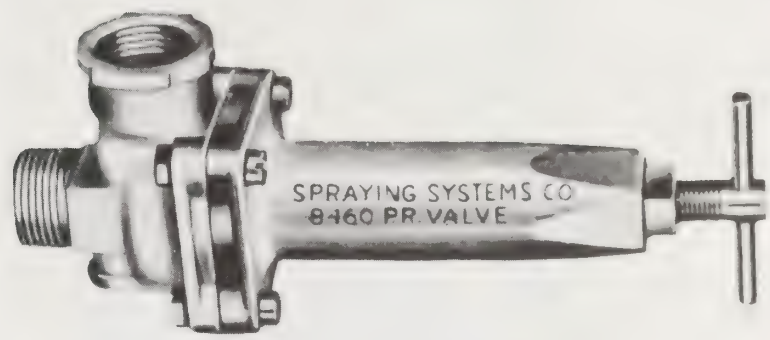
- Plug the hydraulic motor ports to retain some hydraulic oil in the motor and prevent internal rusting.
- Remove the bottom vent plug in the pump and drain the fluid. Flush some light oil in the pump to cover internal parts and prevent rusting.
- Always rotate impeller by hand to be sure the unit is free before reusing.



Ground drive pump

GROUND DRIVEN METERING PUMPS

Metering pumps are driven by a ground wheel. When speed changes, the rate of pumping increases or decreases proportionately. Thus, the application rate is held constant. Variable-stroke piston pumps are designed to change the length of the piston stroke to adjust the application rate. Increasing the piston stroke increases flow; reducing the stroke cuts the flow. Some pumps have a dial setting to indicate the output required. Other models require changing the sprocket size according to the desired volume. These types of pumps are mainly used in liquid fertilizer applicators, however, some manufacturers of herbicide sprayers offer these pumping systems.

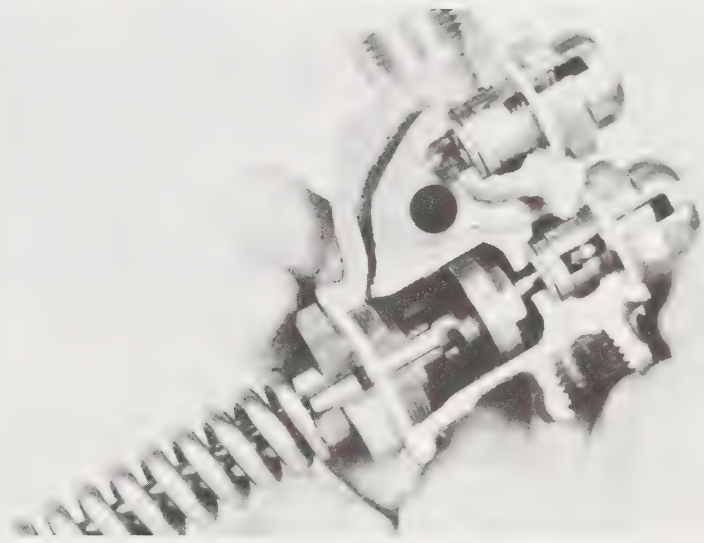


Pressure relief valve

PRESSURE REGULATORS

Relief Valve

A relief valve is a safety device that releases liquid when the pressure exceeds a safe level. Relief valves can be used to regulate sprayer pressure by adjusting them to open at the desired setting. When used this way, the valve is always partly open while the sprayer is operating. The excess flow is bypassed back to the tank.



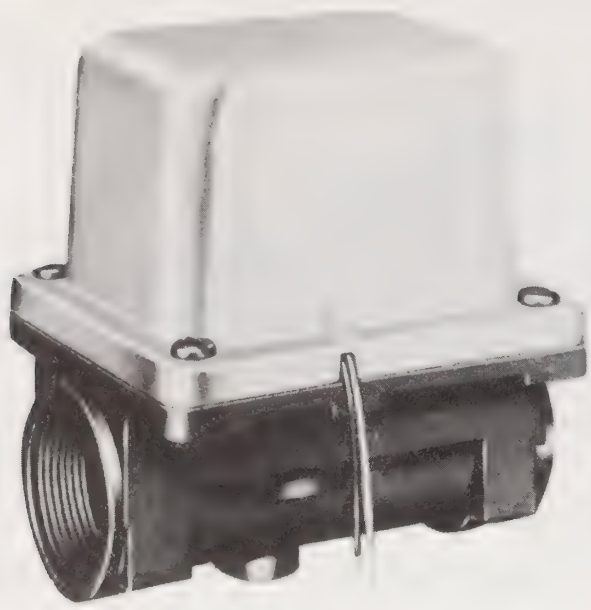
Unloader valve

Unloader Valve

Spraying systems operated at pressures over 1400 kPa should use an unloader valve in place of a relief valve to unload the pump when the distribution system is turned off. An unloader valve opens and enables the pump output to flow back to the tank at low pressure. This reduces pump wear as well as relieving the pressure on the entire system.

Electric Pressure Regulators

This type of regulator provides remote pressure control in agricultural spraying applications. Wetted metal parts are made of stainless steel with nylon body and polypropylene cover for the gear motor. The valve operates on a 12 volt system at pressures up to 700 kPa.



Electric pressure regulator

Pressure gauge

PRESSURE GAUGES

The importance of this item is often overlooked. Its reading is an indication of the rate of application being applied. A spare, accurate gauge should be kept on hand in case of failure and for checking boom pressure.

Pressure gauges should have a total range of twice the maximum reading expected. Gauges reading 0-450 kPa or 0-700 kPa are satisfactory. Gauges should be checked yearly for accuracy. If in doubt, replace the gauge as it is not an expensive item. The gauge should also be equipped with a pulsation damper to prevent damage and to keep the needle from fluctuating. Several manufacturers have glycerin or oil-filled gauges available. The liquid filled gauges dampen any pump pulsations which can damage the gauge and make reading it difficult.

Gauge dampener

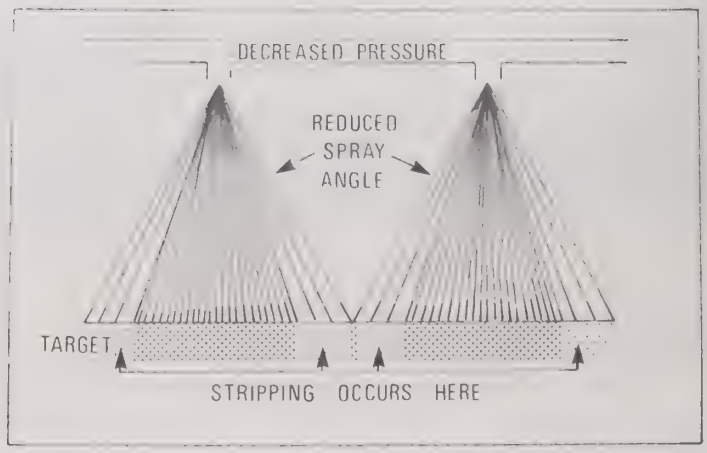
Ideally, sprayer pressure should be taken at the boom near the nozzle; however, most sprayers have the gauge located on the selector valve. To check gauge reading accuracy, a second gauge may be temporarily attached to the boom and readings compared to the one mounted on the selector valve — (THESE READINGS SHOULD BE IDENTICAL). Several sprayer manufacturers have the gauge connected so that it reads actual boom pressure. This is accomplished by running a small flexible line from a boom mid-point to the control location.

PRESSURE LOSS

In any system where flow of liquid is involved there are pressure drops between the pump outlet and the discharge point. The amount of pressure loss depends upon:

- size of hose
- length of hose
- flow rate and
- other fittings in the lines (restrictions).

In field sprayers, the pressure gauge is usually located close to the pump outlet and there can be significant pressure loss by the time the liquid reaches the nozzle. With adequate lines and fittings and proper design, this loss can be kept at a minimum. Many older sprayers (particularly those which were originally designed to apply 20 litres of spray per acre) show severe pressure losses when operated with larger nozzles. Losses as high as 150 kPa can occur and cause severe distortion of the spray pattern, as well as a significant reduction in the application rate.



Results of decreased pressure

PIPE AND HOSE FRICTION TABLES

FLOW	PRESSURE DROP IN kPa FOR PIPE SIZES 3m LENGTH				
IN L/min	½″	¾″	1″	1¼″	1½″
10	2	1			
15	5	1			
20	9	2			
25	13	3	1		
30	19	4	1		
40	32	8	2		
50		12	3	1	
60		17	5	1	
70		22	7	2	
80			9	2	
90			11	3	1
100			13	3	1

NOTE: The above figures are for standard pipe of either seamless or welded construction, in good clean condition. Recommended maximum capacity to keep velocity at approximately 1.5 m per second is shown above heavy lines.

FLOW	PRESSURE DROP IN kPa FOR VARIOUS HOSE SIZES				
IN L/min	½″ I.D.	⅛″ I.D.	¾″ I.D.	1″ I.D.	1¼″ I.D.
10	17	5			
15	40	12			
20	67	20	8		
30		45	17	4	
40		72	29	7	
50			44	11	
60			61	15	5
70			83	20	7
80				26	9
90				32	12
100				38	14

NOTE: The above figures are for standard hose in good, smooth condition (7.6 m length with no couplings).

Pressure drop can also occur on the inlet or suction side of the pump. The allowable restriction at this point is critical, since the pump output and life can be affected. A total pressure drop of less than 30 kPa is desirable. This includes the total drop through fittings, filter and inlet hose. Since most filters, when clean, cause a pressure drop of 15 to 25 kPa (depending on the flow rate), it is necessary that the remainder of the suction line not cause a pressure drop of more than 15 kPa at maximum flow. Hose and fitting sizes must be correctly chosen. A large pressure drop will shorten the pump life and drastically reduce output.

Pressure drops can be reduced by selecting the correct line sizes, minimizing the number of fittings, elbows or sharp bends and reducing the length of hoses as much as possible.

Every attempt should be made to use the largest fittings that are available for the hose size. To illustrate how serious these restrictions can be, a 30 cm length of 6 mm pipe inserted in a 12 mm line carrying 16 L/min would cause a pressure drop of nearly 55 kPa, or over twice the pressure drop in a 4.5 m length of 12 mm diameter hose.

Because of the relationship between spray nozzle, pressure, and height of spray boom, it is important that the desired pressure be maintained at the nozzles. Usually the pressure at the nozzles can only be determined by placing a pressure gauge in the boom itself.

Note: Use of ball check strainers at the nozzles requires a 35 kPa increase in pressure to maintain correct nozzle output.

FILTERS AND STRAINERS

Precautions:

a) Loss of flow and/or pressure is often the result of blocked filters. Clean regularly, and carefully observe safety precautions for handling contaminants.
b) Excessively fine filtration can cause a proportion of certain wettable powders to be 'screened off', and the chemical manufacturer's recommendations should always be checked.
c) Mesh size refers to the number of holes per 25 millimetres.

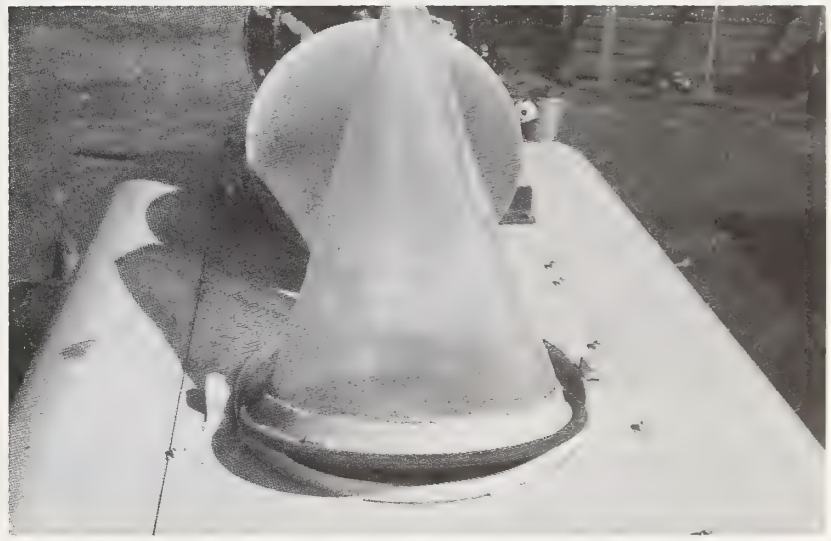
NB: The filters should be located where risk of damage is minimized, but where access for cleaning is not inhibited.

General Principles:

Filtration should be operated in stages, starting with a coarse mesh and progressing to finer screens at strategic points along the direction of flow. The mesh sizes selected will depend upon the rate of flow of the liquid, and the nature of the chemicals in it.

The stages of filtration in a sprayer are generally as follows:

a) **Filtration into the tank via the foot strainer and the basket strainer.** An 80 or 100 mesh screen should be used in the tank filler opening. This will effectively prescreen the material before it enters the tank.

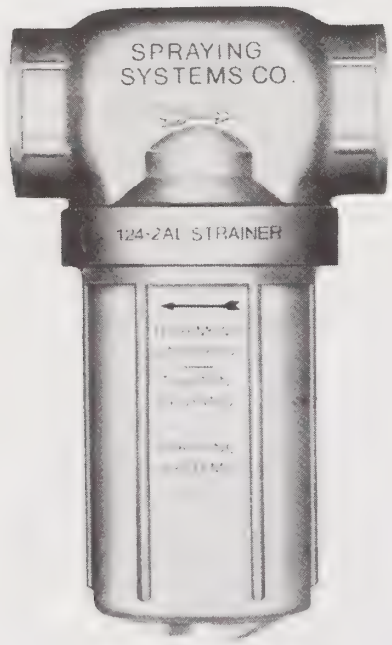


Basket strainer

Foot valve

b) **Filtration between the tank outlet and the pump, via the suction strainer.** This provides protection for the pump, and preliminary screening of the liquid prior to the pressure filters. This filter is located between the tank and the pump when using roller, piston and turbine pumps and located between the pump and booms when using a centrifugal pump. The reason for this is that the centrifugal pump can handle foreign material without damage. By having the filter between the pump and booms, a much smaller volume of tank solution is filtered. A 50 or 60 mesh filter is satisfactory for most solutions. Wettable powders require a 50 mesh filter. In order to maintain efficient filtration, without restricting liquid flow, the screen area should be as large as possible, with adequate clearance around the element in the filter housing.

Felt filters have been replaced by metal screen filters as they provide more filter area, are easier to clean and handle wettable powders.



Suction or pressure line strainer

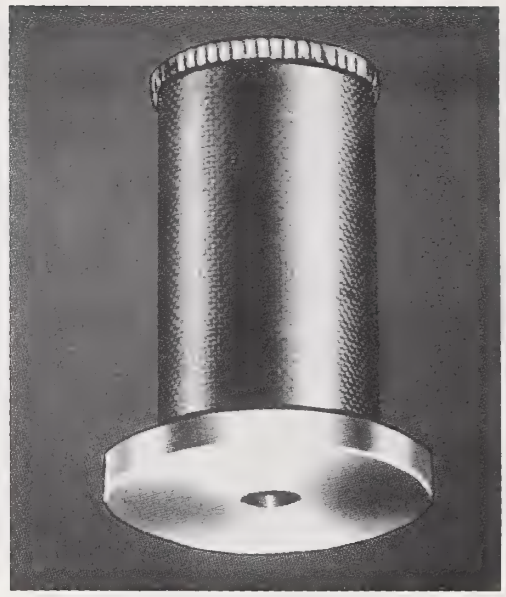
c) **Filtration between the pump and the nozzle tips.** Pressure line strainers are the most efficient pressure filters. These are fitted either:
— Between the pump and the pressure regulator, requiring one large pressure line strainer.
— In each hose, feeding the individual spray boom sections.

Nozzle Strainers

In order to help prevent nozzle tip plugging, nozzle tip strainers are recommended. The strainers stop dirt and other particles before they can plug the orifice.

The size of strainer depends on the tip size and the type of solution. A 50 mesh screen or equivalent slotted strainer is normally sufficient for larger tips (02 and up) and for wettable powders. An 80 or 100 mesh screen is normally used with smaller tips.

Always check whether the chemical manufacturer has made filtration recommendations on the label.

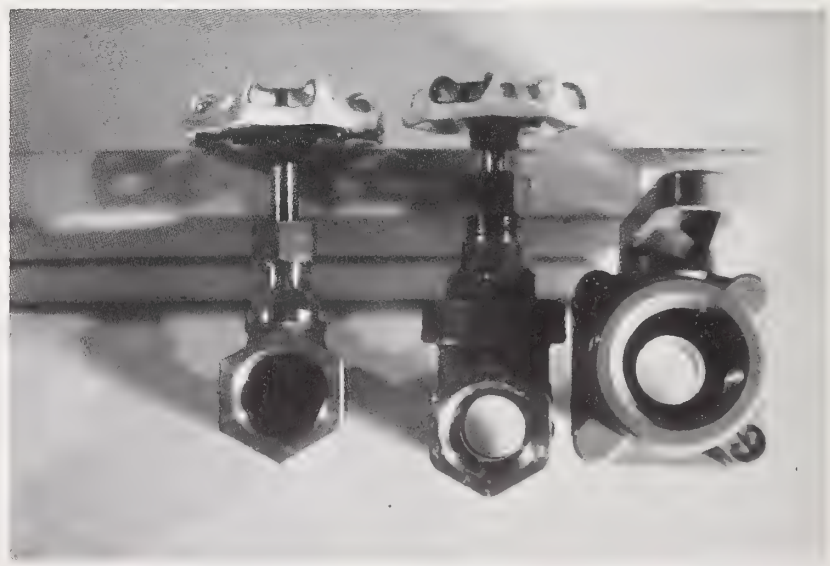


Nozzle strainer

VALVES

Valves are required at several points throughout the plumbing system of the sprayer. Depending on the application, gate valves or ¼-turn ball valves are recommended. Valves are required to control the agitation system and the hand gun. A ball valve is normally installed on the suction line upstream from the main filter. This enables cleaning of the filter while there is liquid in the tank. A valve on the tank drain is very handy and can be installed to replace the drain plug. This makes cleaning the tank much more convenient and reduces the chances of the operator coming in contact with the chemical mixture while draining the tank.

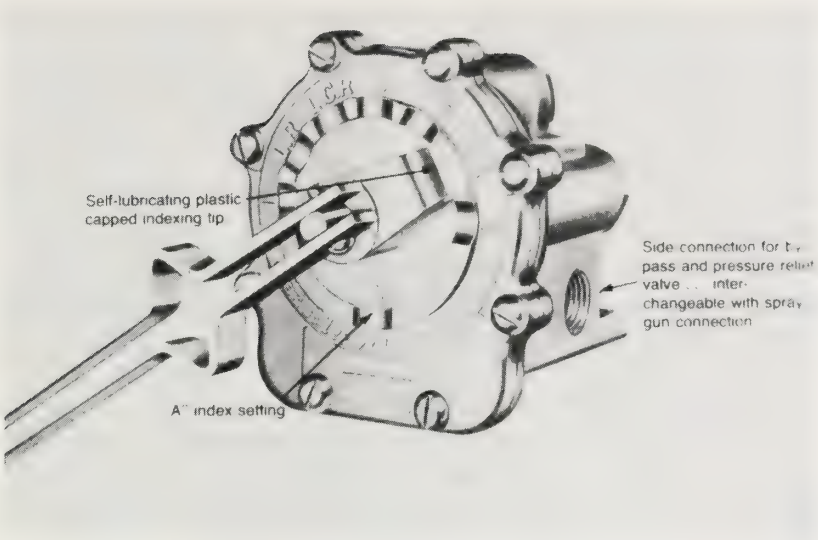
Gate valves (centre) or ball valves (right) are preferred to globe valves, (left). Owing to the design of a globe valve, liquid passing through it must make two 90° turns thus restricting low. Globe valves may be used in lines which require throttling such as the agitation line.



Control valves

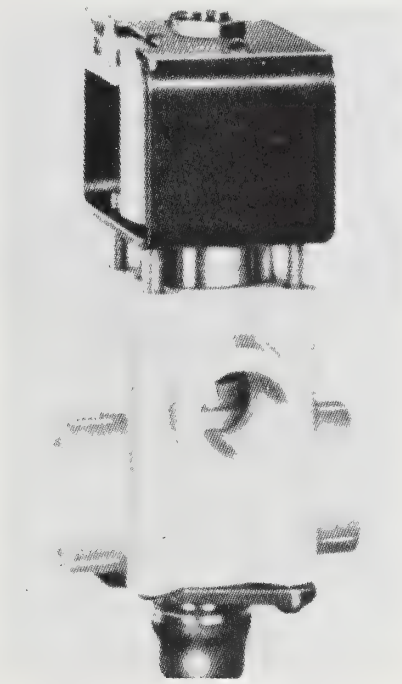
Boom Controls — Control valves used to regulate the flow of liquid are those valves other than the pressure regulator. One of the most common is the 3-section-boom control. This type of control valve permits up to 8 different spraying patterns.

The type of control valves used on a particular sprayer will depend on operating requirements and personal preferences.



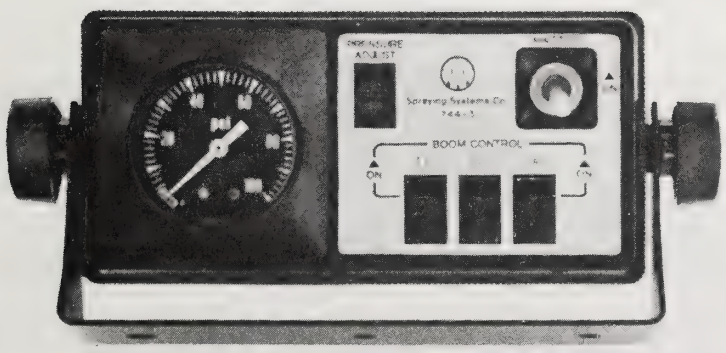
Three-section-boom control

Electric solenoid valves are available in materials resistant to all common herbicides. These valves may be mounted on the sprayer and controlled remotely from the driver's seat. Advantages include easier, faster control, a shorter and less complex plumbing system, and increased operator safety as there are no hoses with chemical near the operator. Pressure drop from the inlet to the spray line outlet is about 35 kPa with most electric solenoid valves.



Electric solenoid valve

A sprayer control system provides on/off control of sprayer booms, plus control of sprayer pressure from the seat of the tractor or truck cab.



Remote boom & pressure control

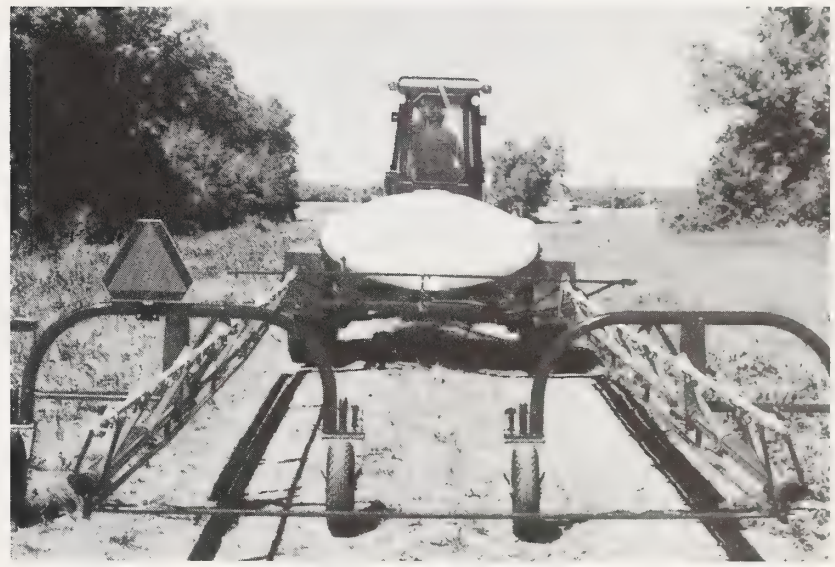
HOSES

Hoses convey the liquid through the sprayer. Liquid pressure varies at different points on the sprayer. Hoses and pipes must be strong enough to prevent bursting. The rated working pressure of a hose decreases as the diameter increases. Be sure hoses are rated for higher capacity than the expected operating pressure to provide a margin of safety and avoid bursting from pressure surges.

Suction hoses are not pressurized and will not burst, but they can collapse if the inlet becomes plugged. Suction-hose diameter should be at least as large as the pump inlet port. The hose must be chosen carefully and should be of the noncollapsing, wire-reinforced type. A collapsed suction hose can restrict flow of liquid and "starve" a pump, causing decreased outflow and greatly accelerated wear.

The inner and outer layers of all hoses should be resistant to the chemicals to be used. Check with both the chemical supplier and the hose supplier if there is any doubt. A hose weakened by chemical attack can leak or burst unexpectedly.

Hose size is important because pressure losses affect flow rates. Pressure loss depends on hose diameter, length and flow rate. Although pressure losses may not seem significant in hoses shorter than 2 metres it's wise to always use hose of the recommended size to minimize pressure and power losses.



Broadcast boom

BOOM SYSTEMS

The boom is usually made of aluminum because of its light weight; however, galvanized steel pipe is also used because of its higher strength. The pipe size depends on sprayer width and application rates. A 25 mm diameter pipe is normally satisfactory for larger sprayers while a 20 mm tube is sufficient for smaller ones.

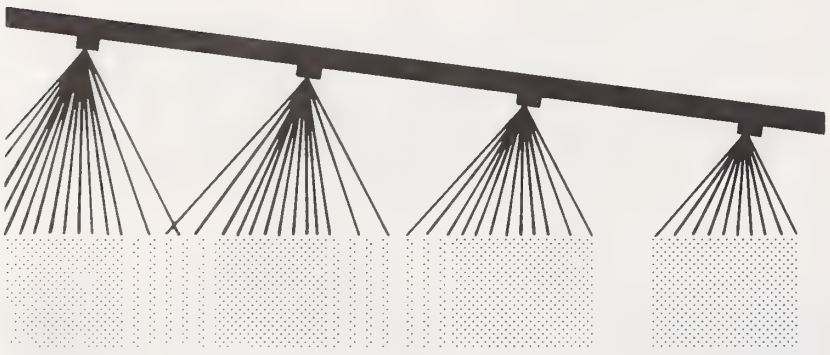
The boom of a sprayer is normally mounted on a support to provide stability and to maintain correct boom height. Whipping, either horizontal or vertical, can result in changes in application rate of 25 to 30 per cent at the boom end when the wheel goes over a 5 cm bump. Castering boom support wheels should be locked into position to provide more directional stability. Locking in transport is also necessary to avoid wheel whip experienced with the non-rigid support of caster wheels. The maximum width of sprayer booms which will give good coverage will depend on the levelness of the fields. In areas with rolling land,

ravines and short steep slopes, the use of very wide sprayers should be avoided. In these situations, it is impossible to maintain correct boom height with a very wide boom. The height of the boom should be easily adjustable between 25 and 100 cm or higher. A convenient adjustment is necessary to allow spraying at a forward angle of 45° without the spray hitting the boom wheels or frame. Booms should fold easily for transportation.

Booms must be stable. Unstable booms produce an erratic spray pattern which results in uneven weed kill and/or crop damage. Poorly supported booms, and booms that are too long, will "whip" in the field. Two types of boom whip encountered are vertical and horizontal.

Vertical Boom Whip

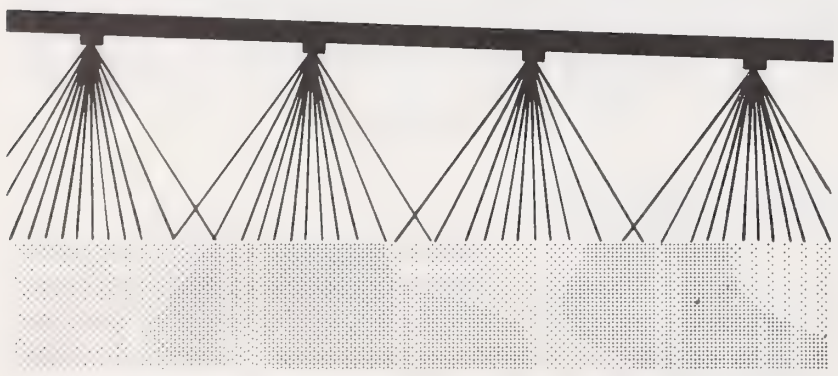
On uneven ground, the ends of long, unsupported booms whip up and down. This produces uneven application. Outrigger wheels will reduce vertical whip to a minimum.



Vertical whip

Horizontal Boom Whip

Rough ground, poorly braced booms, and a loose hitch between the sprayer and tractor can combine to give horizontal boom whip. This will produce a patchy spray pattern. Stabilizer bars, securely pinned drawbar, and a ball and socket hitch will help to eliminate horizontal whip.



Horizontal whip

Self-Stabilizing Booms

Many tractor mounted and truck mounted sprayers come equipped with booms without outrigger wheels. Booms without wheels, supported by chains or cables, have a tendency to bounce and dig into the ground while turning in the field. The newer types of booms are trapeze mounted (either single or double) and tend to be more stable than chain supported booms especially in rough fields. A skid is mounted on the outer ends of these booms to prevent the nozzles from contacting the soil surface.

Shrouded Booms

Sprayers with booms covered by various sorts of wind-protecting shields have appeared on the prairie market. The obvious advantage is that they allow spraying to continue in windy conditions.

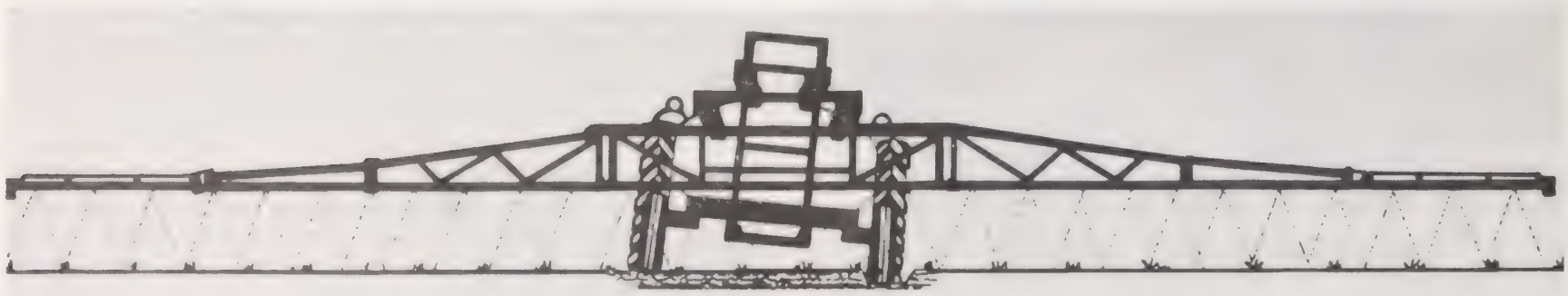
Covered boom

Some possible disadvantages are:

- operator cannot see the nozzles in operation
- difficult to carry out nozzle tip calibration
- difficult to clean underneath some models
- possible buildup and subsequent run off of herbicides causing crop damage.

Although there are electronic nozzle monitors available that warn the operator when plugging occurs the monitors cannot indicate if the spray pattern is distorted.

Contour boom



Self-stabilizing boom

Articulating Roadside Sprayer Boom

Regardless of roadside terrain, from ditches to almost vertical banks, and all between, a contour-matic three section boom can be articulated into many convenient configurations. You can have straight angle up or down, L shape up or down, Z shape up or down or whatever you need to place the spray nozzles very close to the foliage being sprayed. A contour-matic boom is controlled hydraulically, and has a seated control position adjacent to inboard end of boom for easy and accurate operation.

These booms are available in 8 metres or 10 metres wide. An o.c. nozzle mounted on the end section can provide coverage to a maximum of 15 metres.

Boom with O.C. Nozzles

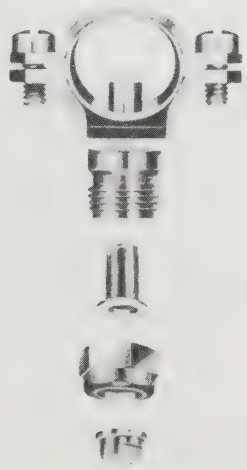
This is a hydraulic operated boom which can be controlled from inside the truck cab. One o.c. nozzle covers the portion of ditch next to the road while the second o.c. nozzle at boom end provides extended coverage into the roadside ditch up to 12 metres.

Front mount boom

NOZZLE BODIES

Wet Boom

A great majority of field sprayers used in Western Canada are classed as "wet boom" sprayers. This means that the liquid is supplied to the nozzle tips through a pipe. The nozzle tips are attached to the pipe at 50 cm spacing and this spacing is not adjustable. The older style nozzle body had a threaded cap which holds the nozzle tip in place.

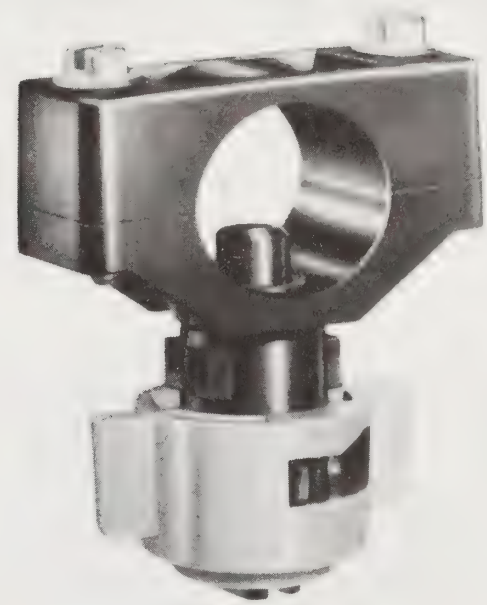


Wet boom nozzle assembly

These nozzle bodies are usually made from brass and are held in place with a stainless steel or plastic pipe clamp.

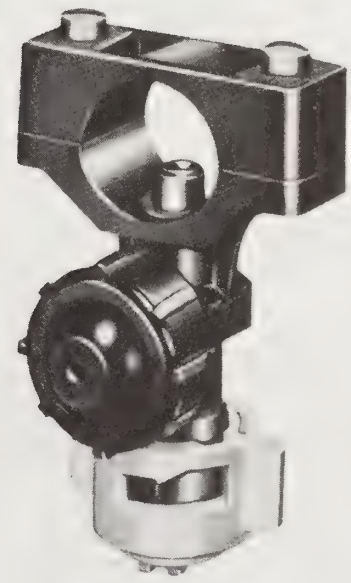
Newer designs of nozzle bodies and boom clamps are generally all manufactured from various forms of nylon regardless of the manufacturer. The new designs virtually all have a quick connect nozzle cap which only requires a quarter turn to attach or to remove the nozzle cap. This feature makes it easy to remove tips and strainers for changing or cleaning.

The newer design nozzle caps have another advantage over the threaded style. The nozzle tips fits into a slot in the cap thus becoming self aligning. This automatic aligning feature ensures that the spray patterns from adjacent nozzles do not hit each other and distort the pattern in the overlap area.



Quick connect nozzle assembly

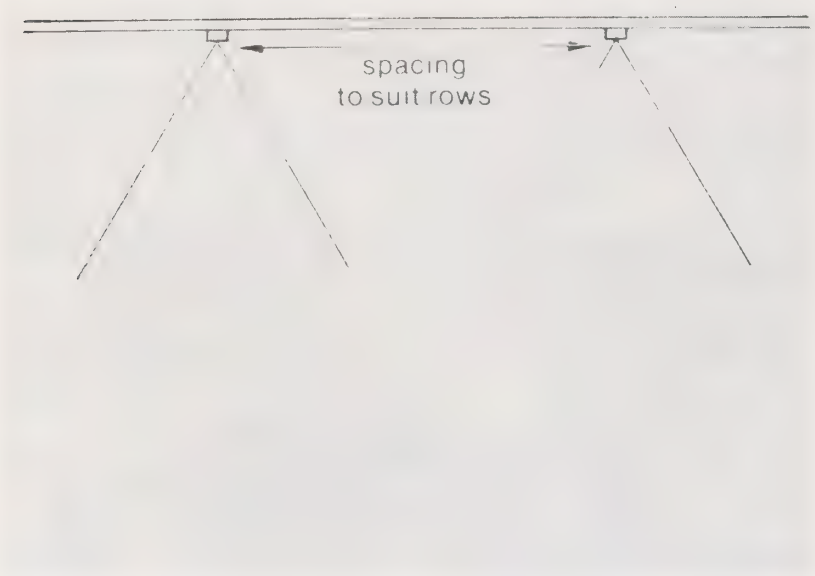
The new design of nozzle body is also available with a diaphragm check valve to prevent nozzle dripping when the sprayer is shut off. (See nozzle check valves.)



Quick connect with diaphragm

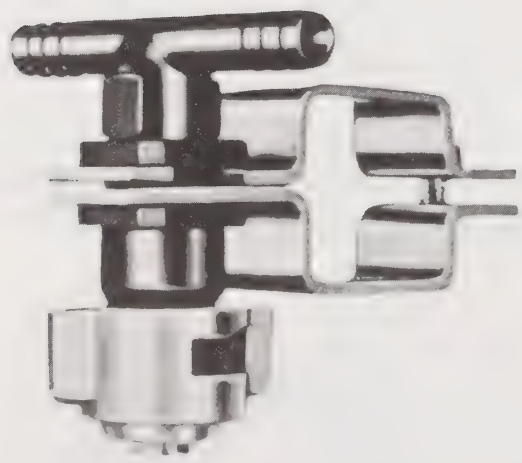
Dry Boom

Dry boom assemblies were originally designed for spraying row crops of various spacing. For this reason the nozzle spacing had to be adjustable. Pipe and round or square tubing are used to support the nozzles and the liquid is fed through hoses to the nozzles.



Row crop spraying

The new design of quick connecting nozzle caps is available for dry booms as well as for wet booms.



Dry boom quick connect nozzle assembly

NOZZLE TIPS

The successful performance of a crop chemical is highly dependent on its proper application as recommended by the chemical manufacturer. Proper selection and operation of spray nozzles are very important steps in accurate chemical application. The volume of spray passing through each nozzle plus the droplet size and spray distribution on the target can influence pest control.

Critical in controlling these three factors is the spray tip orifice. Careful craftsmanship goes into the precision machining of each orifice. Although a dealer can help in spray tip selection, the maintenance of those tips rests solely in the hands of the user.

Nozzle tips are available in brass, nylon, stainless steel, hardened-stainless steel and ceramic.

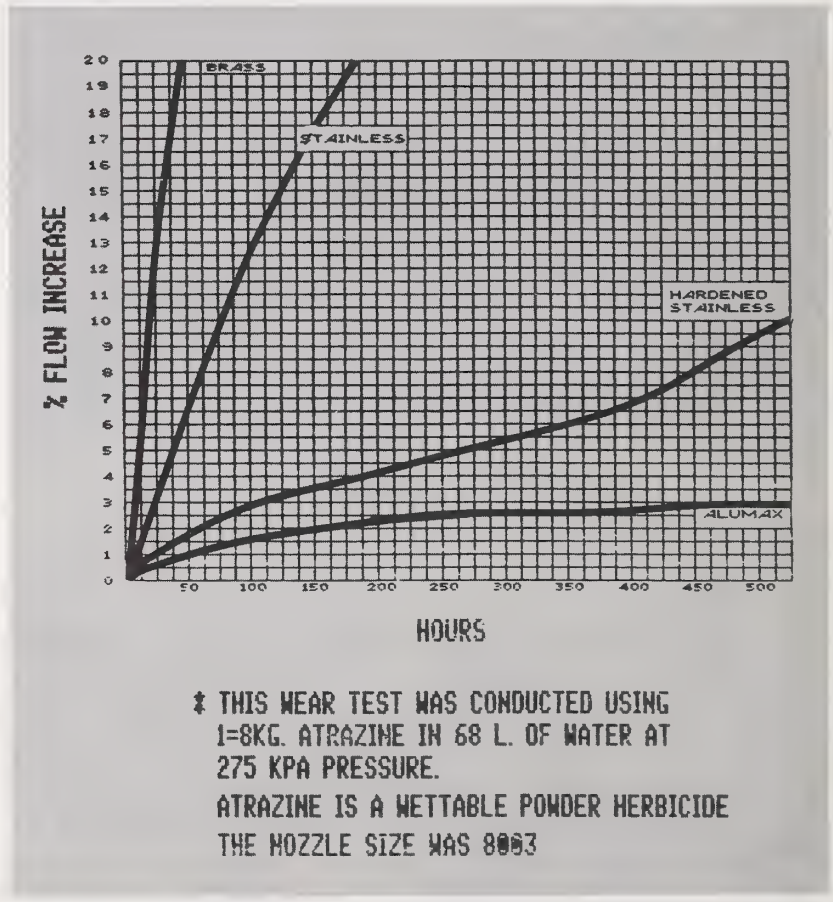
Brass tips have been the most poplar because of their availability and initial low cost but the use of stainless steel tips has been steadily increasing owing to their superior wear characteristics.

Various makes of nylon tips and plastic tips are available but little is known about their life expectancy or long term performance characteristics.

As a nozzle tip wears, the spray pattern distorts, output volume increases and the droplet characteristics change.

Recalibration may correct for output changes but cannot correct for spray pattern changes.

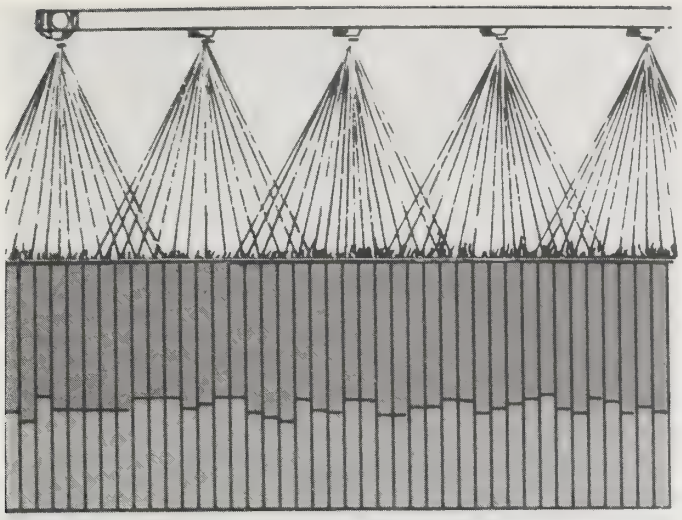
Poor spray distribution can be prevented. Selection of longer wearing tip materials or frequent replacement of tips from softer materials can eliminate misapplication caused by worn spray tips.



TeeJet nozzle wear chart

Careful cleaning of a plugged spray tip can mean the difference between a clean field and one with weed streaks. Flat spray tips have finely machined thin edges around the orifice to control the spray. Even the slightest damage from improper cleaning can cause both an increased flow rate and poor spray distribution. Be sure to use adequate strainers in your spray system to minimize plugging. If a tip does plug, only use a soft bristled brush or toothpick to clean it... never use a metal object. Use extreme care with soft tip materials. Experience has shown that even a wooden toothpick can distort the orifice.

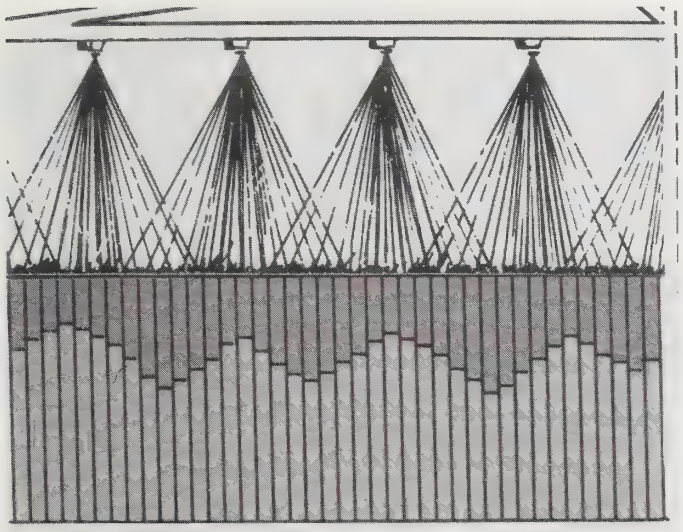
The illustration below compares the spraying results obtained from well-maintained vs. poorly maintained spray tips.



NEW SPRAY TIPS
Produce a uniform distribution when properly overlapped

New spray tips

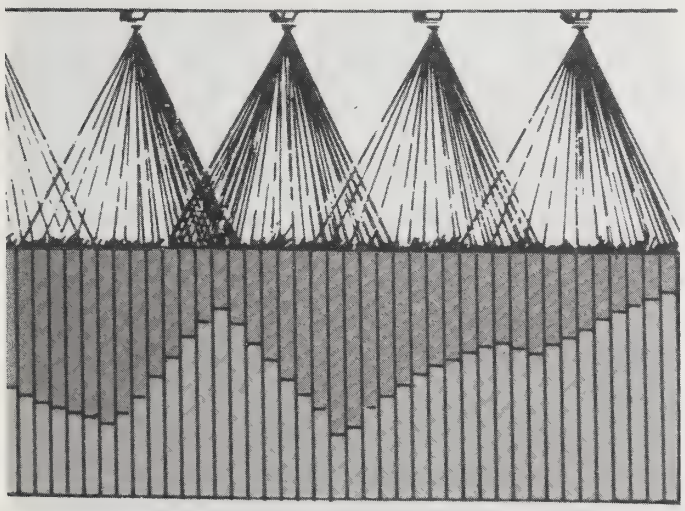
New tip: Note elliptical orifice



WORN SPRAY TIPS
Have a higher output with more spray concentrated under each tip

Worn spray tips

Worn tip



DAMAGED SPRAY TIPS
Have a very erratic output–overapplying and underapplying

Damaged spray tips

Wire damaged orifice

DROPLETS AND NOZZLE SELECTION

Selecting the best nozzle for a sprayer involves a number of factors including droplet size requirements, uniform deposit, required output and durability. These factors are further complicated by the effects of pressure, height and spacing on deposit uniformity and the effect of pressure on droplet size.

Some post-emergent herbicides require very small droplet sizes while others will tolerate somewhat larger droplets. Large droplets will produce less complete coverage and with contact type herbicides the large droplets may burn holes in the leaves of weeds without killing them or roll off the leaves and be wasted. Generally, better insect control is achieved with very small droplets as well.

The danger of spray drift increases rapidly with decreasing droplet size and any droplets less than 100 microns in diameter are prone to drifting off target and are subject to evaporation.

Actual droplet sizes

Nozzles meter the flow of the herbicide and disperse it uniformly over the target area. They also atomize the liquid into droplets small enough to provide good coverage but large enough so that wind drift is minimal.

No atomizer is capable of spraying droplets of equal size. Liquid breakup is caused by the collapse of unstable fluid sheets, jets, or ligaments, or the tearing action of air. These mechanisms produce tiny droplets of one or two microns as well as medium and large droplets extending up to several hundred microns. Finer atomization may be achieved by increasing pressures.

As viscosity of a liquid increases, large viscous forces must be overcome by the energy supplied to the nozzle. This detracts from the energy available for droplet breakup resulting in coarser atomization. With very thick materials, satisfactory atomization becomes difficult, and high operating pressures may be required.

In most cases, large droplets may be expected as nozzle capacity increases. Spray angle rating is also a factor, finer droplets being associated with larger angles. Since the mechanism of breakup is affected by nozzle construction, droplet size varies with nozzle type.

Droplet size is referred to as volume median diameter (VMD) measured in microns. This means that in any given quantity of liquid sprayed, one-half of the volume will be in droplets equal to or smaller than VMD, while the other half of the volume will be in droplets equal to or larger than VMD.

The distribution of droplet size is known for all nozzles and in many cases the greater portion of the spray is in droplets close to the VMD.

Examples:

To illustrate the effect of droplet size when changing nozzle types or spray angles, listed below are some commonly used nozzle tips. These examples assume that each nozzle is the same size (1 litre per minute at 275 kPa).

Nozzle Type	Average Droplet Size
Hollow Cone	260 microns
Flat Fan - 110° angle	300 microns
Flat Fan - 80° angle	400 microns
Flat Fan - 65° angle	475 microns
Flooding Fan	650 microns

For any given size or type of nozzle, increasing pressure reduces particle size. But this effect is much less important than the spray angle of the nozzle.

For example, at 275 kPa the 1 litre per minute 80° flat fan nozzle gave a VMD of 400 microns. Even if spray pressure were more than doubled, VMD would only be reduced to 380 microns. Whereas you could reduce droplet VMD to 300 microns simply by fitting 110° nozzles - and still spray at 275 kPa.

General Nozzle Classification

Spray Description	Droplet Size (Microns)	Nozzle	Used For
Fine Aerosols	0 - 50	Flat Fan Cone	Insecticide - Fungicide
Coarse Aerosols	50 - 100	Flat Fan Cone	Insecticide - Fungicide
Fine Sprays	100 - 250	Flat Fan Cone	Herbicide - Insecticide
Medium Sprays	250 - 500	Flat Fan	Herbicide - Insecticide
Coarse Sprays	500 - 700	Low Pressure Flat Fan	Soil applied herbicides
Very Coarse Sprays	700 - 1000	Flooding Fan Raindrop	

FLAT FAN NOZZLES

The ideal sprayer delivers even coverage of the whole field with a spray consisting of a large number of small droplets. Large droplets give insufficient coverage and very fine drops are subject to drift. The pattern of spray droplets on the target is created by a combination of the following three factors:

1. nozzle type,
2. pressure, and
3. boom height.

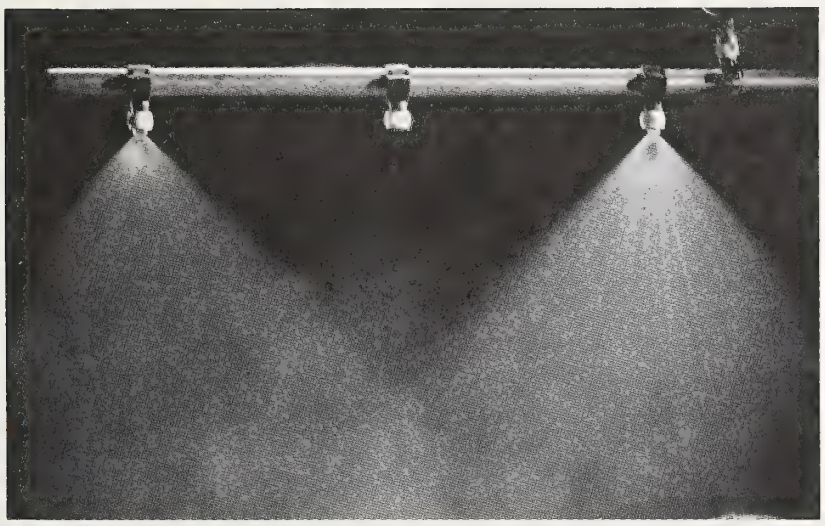
The flat fan spray tip is the most common tip used for broadcast spraying. The droplet and spray pattern characteristics produce a relatively uniform spray coverage.

The tapered flat fan nozzle used for broadcast spraying produces a pattern heavier at the centre than at the edges.

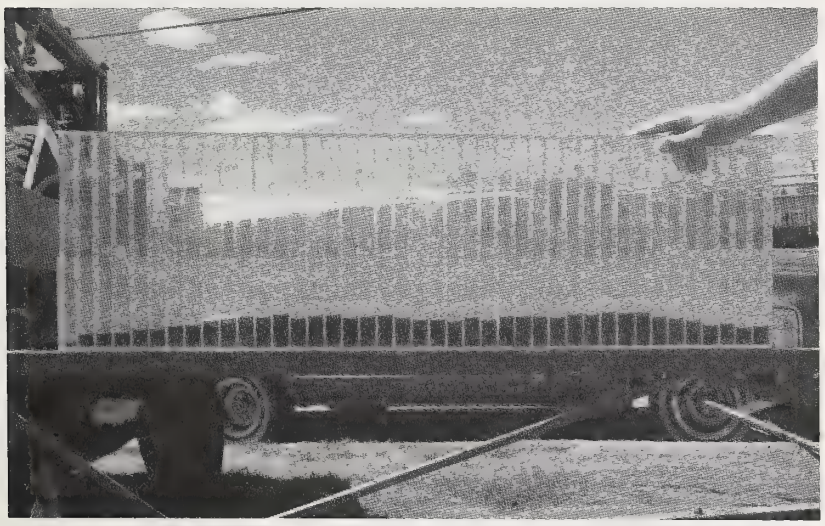
Spray pattern — flat fan nozzle

Spray collected in divided tray
Note: tapered edges

This nozzle is operated with the spray fans of adjacent nozzles overlapping 30 per cent to fill in the light areas and give a uniform pattern.



Spray pattern from two nozzles



Spray collected in divided tray
Note: Centre indicates correct overlap of two nozzles

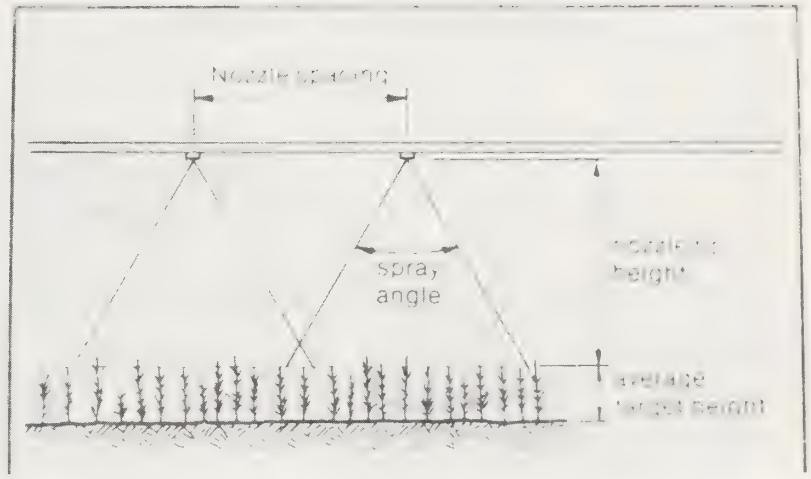
The tapered flat fan nozzle is available in a wide range of sizes and in several spray angles.

With any of the tapered flat fan nozzles, the rated spray angle is produced at only one pressure setting, i.e. 275 kPa. Increasing pressure will produce a wider pattern and smaller droplets while decreasing pressure will produce a narrower pattern and larger droplets. Since each nozzle is designed to operate over a narrow pressure range and since the nozzle spacing along the boom is fixed on most sprayers, all pattern adjustments are made by changing the height of the nozzle above the target. The target for post-emergent herbicides is the weeds, while for soil-applied herbicides, the target is the ground.

Recommended Nozzle Height

Spray Angle of Nozzle	Height (cm)
65°	50 - 60
73°	50 - 60
80°	40 - 50
110°	25 - 45

Proper height also depends on the pressure being used. Standard heights of 40 to 50 cm above the target are just a guide and are appropriate for a nozzle which produces an 80° spray angle, spaced every 50 cm along the boom and operated at 275 kPa. A more accurate way to set nozzle height is illustrated in the following diagram.

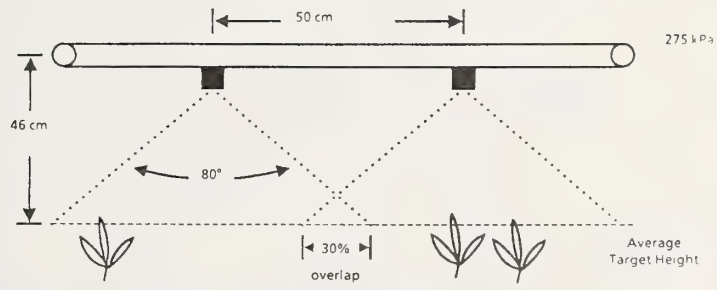


Measuring nozzle tip height

Initially, farmers used a flat fan tip that produced a 65° spray pattern. The correct height above the target for this nozzle tip was about 56 cm to allow for the correct overlap of spray patterns.

As technology progressed, spray drift was recognized as a problem and the wider-angle 80° nozzle tip became the recommended standard. This nozzle should be used at 46 cm above the target using 275 kPa pressure to provide a uniform spray pattern along the length of the boom. The lower boom height allows the spray to enter into the crop canopy more quickly, reducing the potential for drift.

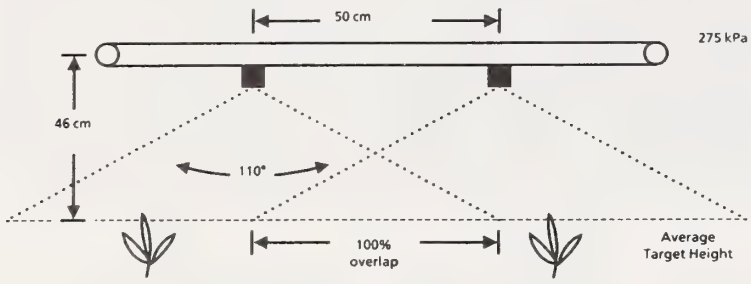
When 80° nozzles are set at the correct height above the target, the spray patterns will overlap about 30 per cent at 275 kPa pressure.



Correct settings: 80° nozzles

Under field conditions a wide variation in boom height will occur owing to weed height differences, uneven terrain and excessive travel speed. Variations in height along the same boom may vary by 10 to 15 cm causing very little or no overlap in areas where the boom is too low.

To overcome the possibility of having misses in the field, the tapered-edge flat fan nozzle with a spray angle of 110° is recommended. When the 110° nozzle tip is set at 46 cm above the target at 275 kPa with nozzle spacing of 50 cm, the spray pattern from one nozzle extends to the middle of the adjacent spray pattern. This 100 per cent overlap will allow for boom height variations to occur without creating misses between nozzle patterns.



Correct settings: 110° nozzles

TeeJet Flat Fan Nozzle Tips and Nearest Equivalents (80° + 110°)

TeeJet	Delavan	Lurmark	Hardi
11001	LF 1 - 110°	01 F 110	4110 - 10
100015	LF 1.5 - 110°	015 F 110	4110 - 12
11002	LF 2 - 110°	02 F 110	4110 - 14
11003	LF 3 - 110°	03 F 110	4110 - 16
11004	LF 4 - 110°	04 F 110	4110 - 20
11005	LF 5 - 110°	05 F 110	4110 - 24
11006	LF 6 - 110°	06 F 110	—
11008	LF 8 - 110°	08 F 110	4110 - 30
11010	LF 10 - 110°	10 F 110	—

The following nozzle chart indicates various outputs of TeeJet tips. Refer to above chart for equivalent nozzles from various manufacturers.

Flat Fan Nozzle Tip Output Chart
(Based on Spraying Water)

80° + 110° Spray Angle

TeeJet Nozzle Tip	Pressure kPa	Litres Per Minute	50 cm Nozzle Spacing Litres Per Acre						
			6km/h	7km/h	8km/h	9km/h	10km/h	11km/h	12km/h
11001	200	.32	26	22	20	17	16	14	13
	275	.38	30	26	23	20	18	16	15
	300	.39	32	27	24	21	19	17	16
110015	200	.48	39	33	29	26	23	21	20
	275	.57	46	39	35	31	28	25	23
	300	.59	48	41	36	32	29	26	24
11002	200	.65	53	44	40	34	32	28	26
	275	.76	62	52	46	40	36	32	30
	300	.79	64	54	48	42	38	34	32
11003	200	.97	79	68	59	53	47	43	40
	275	1.15	93	80	70	62	56	51	47
	300	1.18	96	82	72	64	58	52	48
11004	200	1.30	105	88	80	68	64	56	52
	275	1.52	123	104	92	80	72	64	60
	300	1.58	128	108	96	84	76	68	64
11005	200	1.61	130	111	96	87	78	71	65
	275	1.89	153	131	114	102	92	83	77
	300	1.97	159	136	119	106	95	88	80
11006	200	1.93	158	136	118	106	94	86	80
	275	2.30	185	160	140	122	112	102	94
	300	2.37	191	164	144	128	116	104	96
11008	200	2.58	209	176	160	136	128	112	104
	275	3.04	246	208	184	160	144	128	120
	300	3.16	255	216	192	168	152	136	128
11010	200	3.22	261	222	192	174	156	142	130
	275	3.78	306	262	228	204	184	166	144
	300	3.95	320	272	238	212	190	176	160

Extended Range Flat Fan Nozzle Output Chart

80° + 110° Spray Angle

Nozzle Tip Number	Pressure kPa	Litres Per Minute	Litres per Acre @ 50 cm Spacing				
			8km/h	9km/h	10km/h	11km/h	12km/h
XR11001	100 275	.23 .38	13 23	12 20	10 18	9 17	8 15
XR110015	100 275	.35 .56	21 34	19 30	17 27	15 25	14 23
XR11002	100 275	.44 .76	27 46	24 41	22 37	20 33	18 31
XR11003	100 275	.68 1.12	41 68	36 60	33 54	30 49	27 45
XR11004	100 275	.92 1.50	56 91	50 81	45 73	41 66	37 61
XR11005	100 275	1.18 1.89	72 115	64 102	58 92	52 84	48 77
XR11006	100 275	1.39 2.28	84 138	75 123	67 110	61 100	56 92
XR11008	100 275	1.86 3.01	113 183	100 163	90 146	82 133	75 122

Flat Fan Extended Range Tips (XR TeeJet)

The XR nozzle tip produces a tapered edge spray pattern and is designed to operate over an extended range of pressures to accommodate a variety of conditions. At the operating pressure of 100 kPa this nozzle produces larger droplets which provide drift control and are especially suitable for soil applied herbicides. At an operating pressure of 275 kPa smaller droplets are produced similar to the standard flat fan nozzle tip. Pressures above 300 kPa are recommended only for insecticide or fungicide application.

EVEN FAN NOZZLES

The even spray tip is identical to the flat spray tip except it does not produce a tapered edge pattern. As a result, this tip is not used for broadcast spraying owing to excessive spray coverage if overlap should occur. It is primarily used to band-spray row crops.

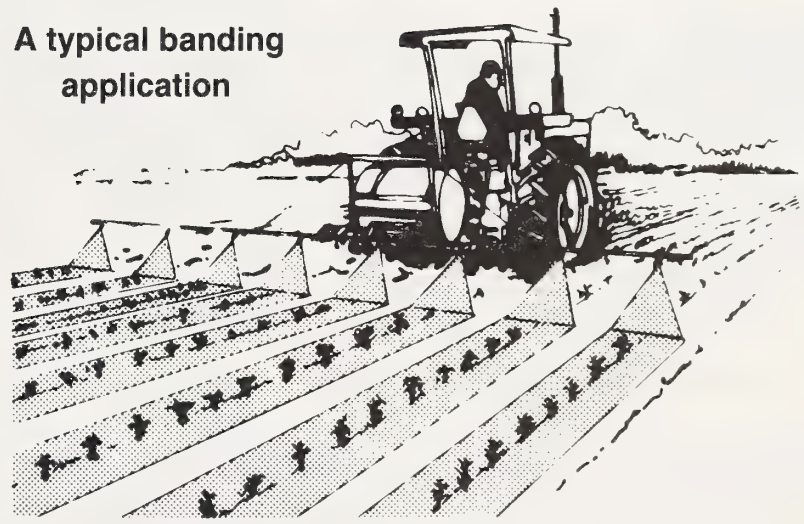
The even spray tips are identified by the letter "E" in the tip designation (e.g. 8001E). The even spray tips have the same output as a flat spray tip with the same volume designation.

However, when band spraying occurs, any nozzle tip will apply various volumes per acre depending on row spacing and the width of the band actually sprayed. This means that any nozzle will give a much higher volume per acre rate on the area actually sprayed in the band than the nozzle would if it were used with the same spacing in a broadcast application.

As chemical rates are given in broadcast application rates and volumes, the following formula will allow calculating the litres per acre for the total field in a band application rate.

$$\frac{\text{Band Width}}{\text{Nozzle Spacing}} \times \text{L/acre (broadcast rate)} = \text{L/acre (band rate)}$$

A typical banding application



Example: Band width 35 cm — Row spacing 100 cm and broadcast rate to be 50 L/acre.

$$\text{Calculate: } \frac{35}{100} \times 50 = 17.5 \text{ L/acre}$$

To pick the correct nozzle tip to use in the above example the following formula will establish the nozzle output in litres per minute that is required to produce 17.5 litres per acre at the desired speed of travel. In this example the desired speed of travel is 12 kmh.

The number of field acres one tank load will cover will be based on 17.5 litres of solution per acre. The amount of pesticide to use can then be determined.

$$\frac{\text{L/acre (band rate) x kmh}}{24282} \times \text{Band Width (cm)} = \_\_\_\_ \text{ L/min}$$

$$\frac{17.5 \times 12}{24282} \times 35 \text{ cm} = 0.30 \text{ L/min}$$

From the Even Fan Nozzle Tip Output Chart that follows, the nozzle 8001E would be chosen for this application. Nozzle calibration at a pressure between 150 and 200 kPa will give the desired 0.30 litres per minute.

Even Fan Nozzle Tip Output

TeeJet Nozzle Tip	Pressure	Litres Per Minute
8001 E	150 200 275	.28 .32 .38
80015 E	150 200 275	.42 .48 .57
8002 E	150 200 275	.56 .65 .76
8003 E	150 200 275	.84 .97 1.13
8004 E	150 200 275	1.12 1.29 1.51
8005 E	150 200 275	1.40 1.61 1.89
8006 E	150 200 275	1.67 1.93 2.27
8008 E	150 200 275	2.23 2.58 3.02

The width of the band required can be controlled by adjusting the nozzle height above the target. Even fan nozzle tips are available with spray pattern angles of 40°, 80° and 95°. The following chart indicates the approximate band width achieved at various heights with the various spray angles.

Band Width (cm)	Approximate Nozzle Height (cm) 40°	80°	95°
20	25	13	10
25	30	15	13
30	35	18	15
35	43	20	18
40	48	24	21

FLOODING FAN NOZZLE

This tip is a variation of the even edge design with the spray angle extended at 110° - 145°. The spray produced is not as uniform as the flat spray. It does, however, result in less drift. Normally, flooding nozzles are spaced 100 cm apart with a boom height that results in little or no overlap.

The flooding tips are not recommended for any herbicide application in a crop situation because of the erratic spray pattern produced.

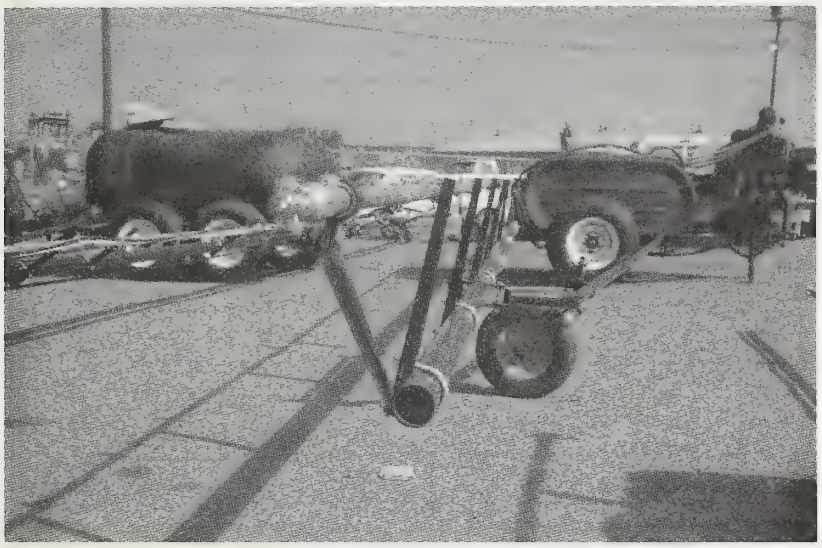
Flooding fan spray pattern

Flooding Fan Nozzle Tip Output Chart
(100 cm Spacing)

Nozzle No.		Pressure kPa	Litres Per Minute	Litres per Acre @ 50 cm Spacing			
TeeJet	Delavan			6km/h	8km/h	9km/h	10km/h
TK .75	D 75	250 275	.54 .57	22 23	17 18	15 16	13 14
TK 1	D 1	250 275	.72 .78	29 31	22 23	19 21	17 19
TK 1.5	D 1.5	250 275	1.08 1.13	44 46	33 35	29 31	26 28
TK 2	D 2	250 275	1.44 1.51	58 61	44 46	39 41	35 37
TK 2.5	D 2.5	250 275	1.80 1.89	73 77	55 58	49 51	44 46
TK 3	D 3	250 275	2.16 2.26	89 93	67 70	59 62	53 56

OFF-CENTRE NOZZLE (O.C.)

Off-centre nozzle tips are usually referred to as boom-end nozzles. Most field sprayers come equipped with these nozzles and have a shut-off valve provided. O.C. nozzles should not be used for overall herbicide application in crop as the spray pattern is not very uniform. These nozzles should be used only on headlands, slough areas and fencelines to provide extended coverage where the boom nozzles cannot reach. The coverage extends from one to three metres depending on nozzle size, pressure and wind conditions.

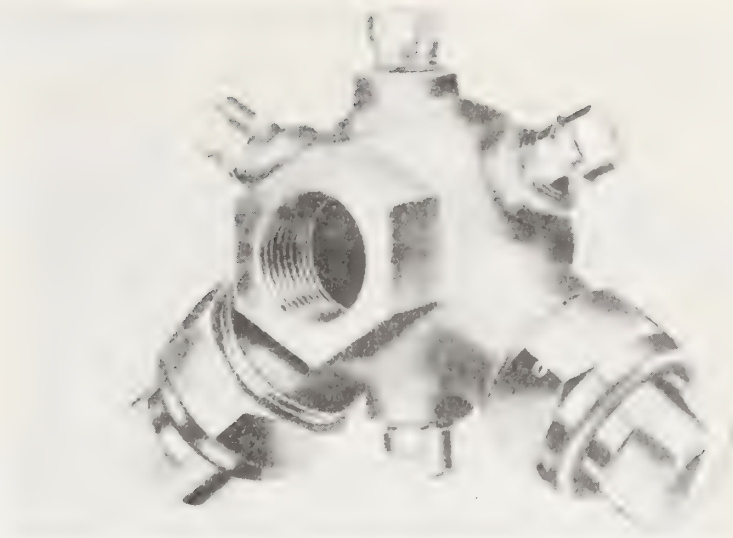


Boom-end nozzle

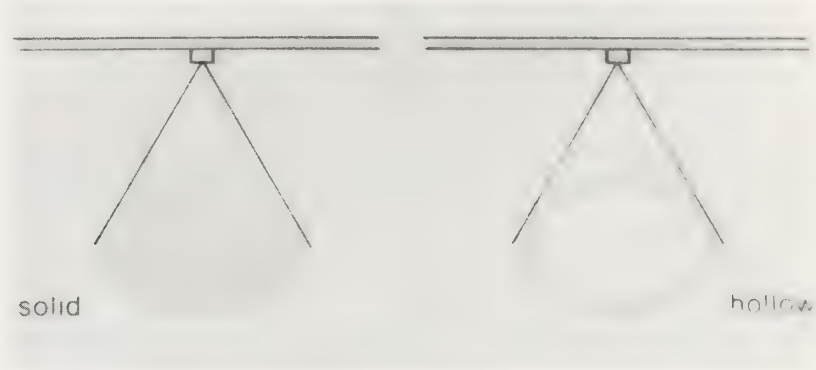
Large capacity o.c. nozzles are designed to provide a boomless spray and are used for spraying roadside ditches, pastures and other areas too rough for boom sprayers or where there are many obstacles such as brush and fences. These nozzles provide coverage up to 10 metres depending on nozzle size, pressure and wind conditions.

Large O.C. nozzle

A combination of two large o.c. nozzles mounted together form a single unit called a boomjet nozzle for spraying in rough pasture and rangeland. This system can be mounted behind a truck, tractor or trailer sprayer and can cover up to 18 metres.



Boomjet boomless spray nozzles



Cone nozzles

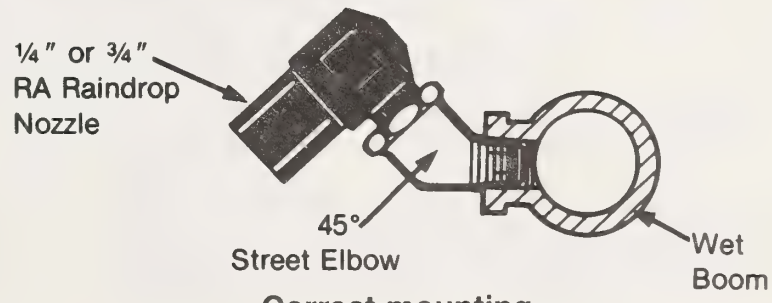
CONE NOZZLES

Hollow cone and solid cone nozzles are popular for row-crop spraying. They are used on spray booms and with handguns. The spray angle may be from 30° to 120°. Hollow cone nozzles generally produce a finer, more uniform spray than the solid cone type.

These nozzles are useful for applying insecticides but are not generally used for broadcast application of herbicides as a uniform spray pattern cannot be achieved in the overlap area between two nozzles on a boom.

Example of cone nozzle use for applying insecticides.

Cone nozzle use



Correct mounting

O.C. Nozzle Output Chart
(Small)

¼ T Off-Centre Nozzle No.	Pressure kPa	Litres Per Minute	Litres Per Acre Spraying Height 45 cm				
			Width in (cm)	6km/h	8km/h	9km/h	10km/h
O.C. 02	200 300	.65 .79	172 177	15 18	11 14	10 12	9 11
O.C. 03	200 300	.97 1.18	195 203	20 23	15 17	13 15	12 14
O.C. 04	200 300	1.29 1.58	231 236	22 27	17 20	15 18	13 16
O.C. 06	200 300	1.93 2.37	251 256	31 38	23 29	21 25	19 23
O.C. 08	200 300	2.58 3.16	254 259	41 49	31 37	27 33	25 29
O.C. 12	200 300	3.87 4.74	259 264	60 72	45 54	40 48	36 43
O.C. 16	200 300	5.16 6.32	335 350	62 72	47 54	41 48	37 43

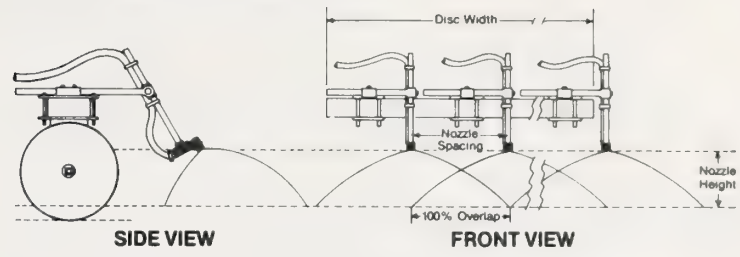
O.C. Nozzle Output Chart
(Large)

¾ T Off-Centre Nozzle No.	Pressure kPa	Litres Per Minute	Litres Per Acre Spraying Height 90 cm				
			Width in metres	6km/h	8km/h	9km/h	10km/h
O.C. 10	200 300	3.20 3.95	5.4 5.6	19 21	17 19	15 17	13 14
O.C. 20	200 300	6.45 7.90	7.1 7.4	28 32	25 28	22 26	19 21
O.C. 40	200 300	12.8 15.8	7.9 8.2	49 58	44 52	39 46	33 39
O.C. 80	200 300	25.8 31.6	8.8 9.1	89 105	79 93	71 84	59 70
O.C. 150	200 300	48.3 59.2	9.3 9.6	158 186	140 165	126 149	105 124
O.C. 300	200 300	96.7 118.0	9.7 10.0	303 364	269 324	242 291	202 243

RAINDROP NOZZLES

Raindrop nozzles produce large droplets which can significantly reduce spray drift. In order to get good patterns from a raindrop nozzle, they must be mounted at 45° to the horizontal, rather than straight down, as with other nozzle types. The very large droplets produced will not provide adequate coverage with foliar-applied post-emergence herbicides, so they are generally used for soil-applied herbicides. They are also quite useful for specialized purposes such as roadside spraying, aerial application, and in urban areas to avoid drift problems.

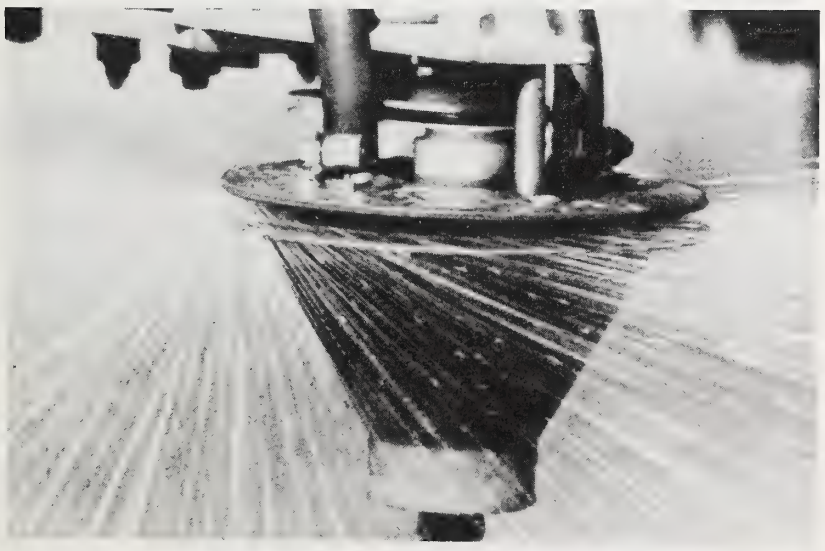
For Spraying While Incorporating



Raindrops on incorporating implement

Raindrop Nozzle Output Chart

Nozzle Number	Pressure kPa	Litres Per Minute	Litres Per Acre					
			50 cm Spacing			100 cm Spacing		
			6km/h	8km/h	10km/h	6km/h	8km/h	10km/h
RA 2	200 275	.64 .76	52 61	39 46	31 37	26 30.5	19.5 23	15.5 18.5
RA 4	200 275	1.29 1.51	104 122	78 92	63 73	52 61	39 46	31.5 36.5
RA 5	200 275	1.61 1.89	130 153	98 115	78 92	65 76.5	49 57.5	39 46
RA 6	200 275	1.93 2.27	157 183	117 138	94 110	78.5 91.5	58.5 69	47 55
RA 8	200 275	2.58 3.02	209 245	157 183	125 147	104.5 122.5	78.5 91.5	62.5 73.5
RA 10	200 275	3.22 3.78	261 306	195 229	157 183	130.5 153	97.5 114.5	78.5 91.5
RA 15	200 275	4.84 5.67	397 461	297 346	238 277	198.5 230.5	148.5 173	119 138.5
RA 20	200 275	6.45 7.56	— —	— —	— —	260 305	195 229	156 183
RA 25	200 275	8.06 9.45	— —	— —	— —	325 383	244 287	195 230



Controlled droplet applicator

CONTROLLED DROPLET APPLICATOR

An electrically driven spinning disc nozzle uses centrifugal force to distribute uniform sized droplets in a 1.8 m circular pattern. Droplet size is controlled by rotational speed and the size of the orifice in the check valve. The unit is belt-driven off a 2-ampere motor powered by a 12-volt battery.

Advantages and Disadvantages As Compared to Standard Nozzles

Advantages:

- — produces a narrow spectrum of droplet sizes with virtually no fines that could evaporate and no large droplets that would run off leaf surfaces.
- — applies low water volumes thus increasing field efficiency.

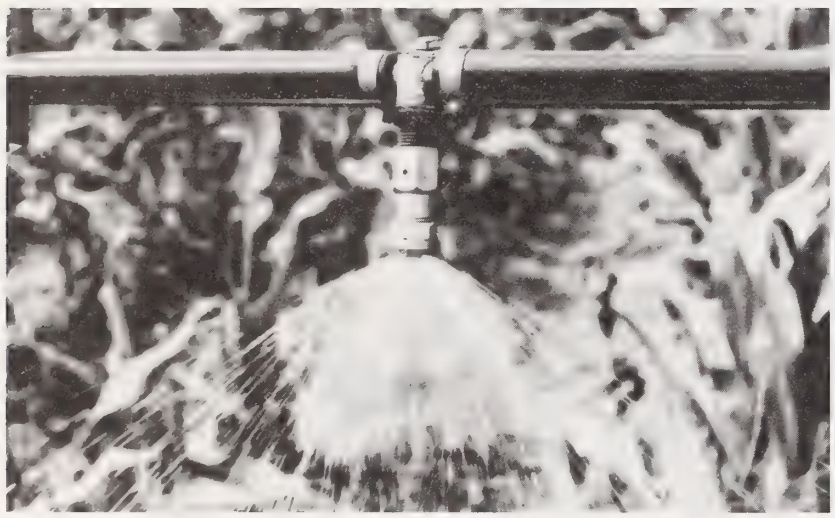
Disadvantages:

- — initial high cost.
- — not capable of applying all pesticide formulations such as wettable powders.
- — more complicated mechanical and electronic components and more moving parts subject to wear.
- — depending on the mixture being sprayed the droplets produced will vary in size at a given disc speed and will be carried a different distance from the disc. With various registered mixes in use the

high concentration of chemicals in low volumes of water create many unknowns insofar as the reaction of surfactants and adjuvants as they relate to crop tolerance, etc.
— label recommendations presently do not allow for low volume application with the exception of aerial application.

ACCUTROL NOZZLES

These nozzles are designed for industrial uses such as spraying roadsides or other rights-of-way. Accutrol nozzles produce large droplets to reduce drift and are designed to be used in combination with a spray adjuvant. The nozzle draws in air and mixes it with the spray to form a milky mixture resembling foam that is visible to the operator. Large V-nozzles are used on a boom and produce a fan shaped spray pattern. Other types of accutrol nozzles are designed for use as a boomless spray system. These can also be adapted to handguns.



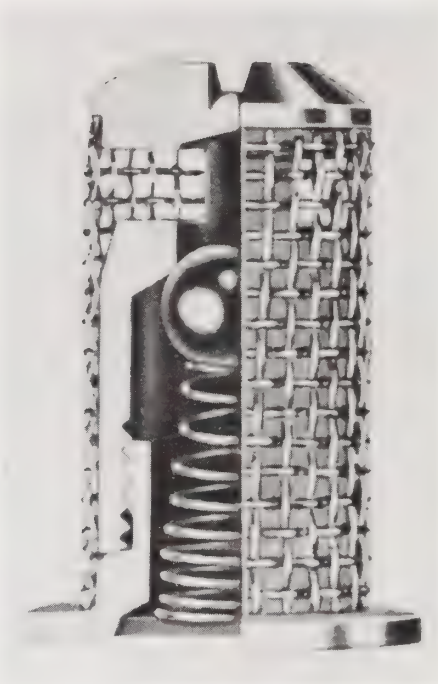
Accutrol V-nozzle

Accutrol F-nozzle

Accutrol system

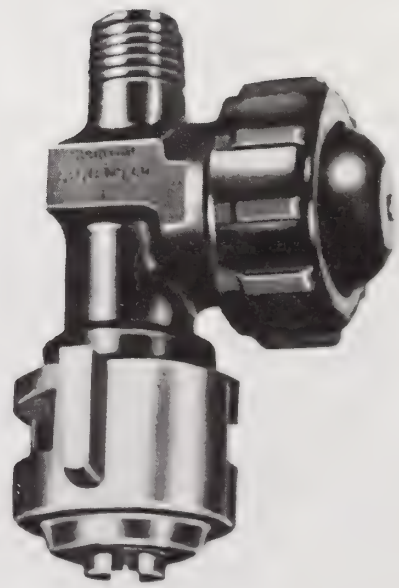
NOZZLE CHECK VALVES

Nozzle check valves can be used to effectively eliminate nozzle dripping when boom pressure has stopped. The valves also provide spray without hesitation, when flow is reapplied. This is accomplished by means of a diaphragm check valve or a spring-loaded ball-check which stops flow through the nozzle when the pressure drops to a certain level.



Ball check valve

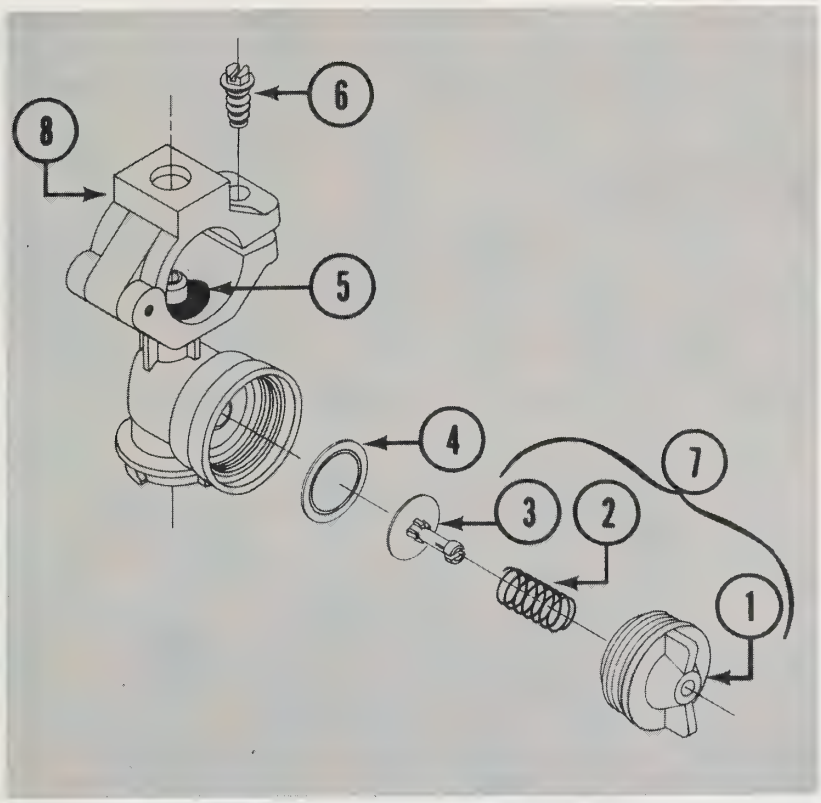
Spraying pressure must be increased by 35 kPa to compensate for a pressure drop through the ball check strainer.



Diaphragm check valve

Diaphragm Check Valves

These types of check valves were originally designed for use in aerial spraying but they are used on ground rigs as well. Maximum operating pressures should not exceed 900 kPa. The spring-backed diaphragm valve assures dependable shut off with no pressure drop at standard agricultural spray volumes.



Diaphragm check nozzle body

Ref. No.	Description
1	Spring Module Cap
2	Spring
3	Pressure Pad
4	Viton® Diaphragm
5	Stem Seal
6	Screw
7	Spring Module Assembly (Ref. #1-3)
8	½" Bridge piece ¾" Bridge piece

Handgun

HANDGUNS

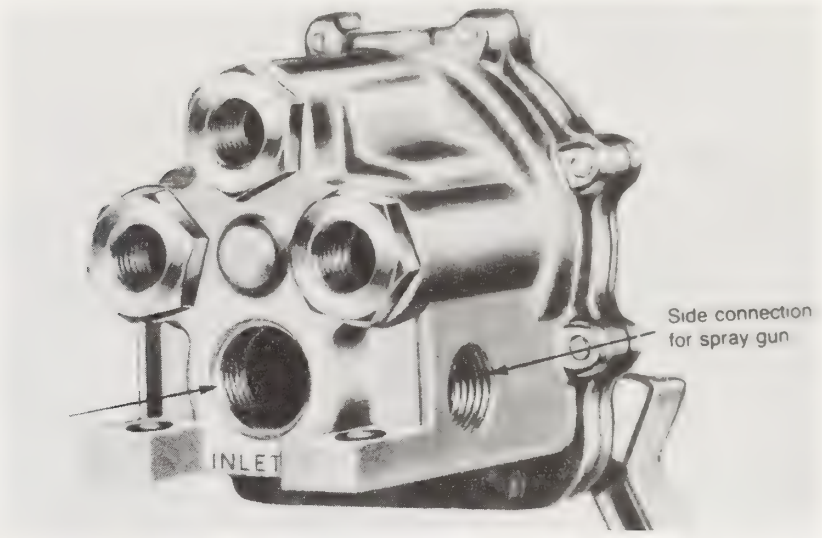
For jobs that are too big for self-contained hand sprayers, or where large amounts of solution are required to wet the foliage, the handgun is a convenient accessory to the field or truck mounted sprayer.

The handgun consists of the gun itself and a length of hose. It is used during field spraying to treat patches of weeds in locations inaccessible to the tractor and sprayer, or to spray areas where weeds or brush are too high to go over with the sprayer itself. Handguns may be added easily to a standard field sprayer. They will be invaluable for treating cattle, for spraying insects in shelterbelts, and for general clean-up work.

Hooking Up A Handgun

A minimum amount of plumbing is required to hook up a handgun. Once the connection to the outlet line is made, it may be permanently left in place.

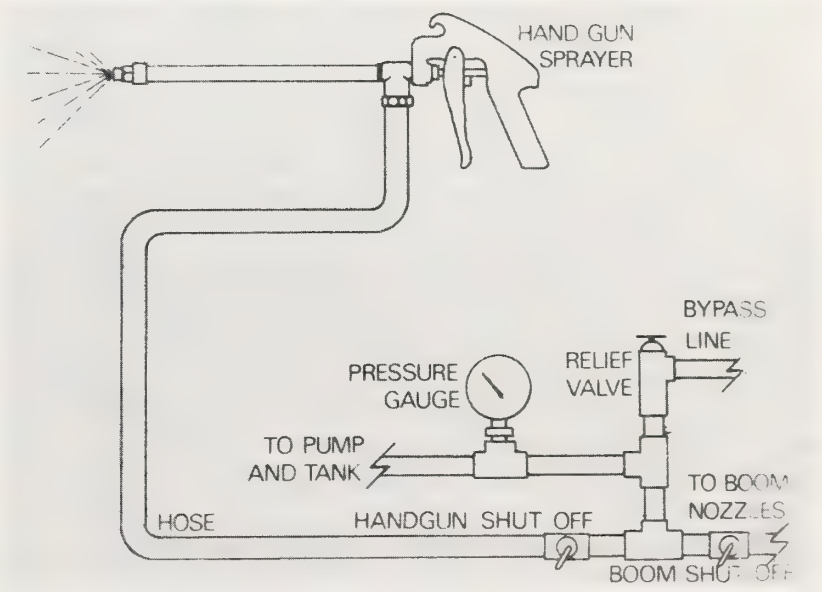
1. Installation should be made in a line between the pump and the boom. If a selector valve is present, the installation can be made right at the valve.



Selector valve

If other types of valves are used the connection should be between the valve and one boom section.

2. A tee is installed at some convenient point between the pump and boom.
3. A nipple is installed in the tee leading to a shut-off valve.
4. A nipple is installed on the other side of the shut-off valve, leading to a hose connector.
5. A hose, at least 8 m in length and leading to the handgun, is hooked into the system at the hose connector.
6. To complete the hook up, a shut-off valve should be installed between the tee and the boom.



Hooking up a handgun

How To Use A Handgun

Controlling weeds with a handgun requires a relatively high volume of spray solution. It is essential that weed foliage be thoroughly covered to the point of run-off.

Output from a handgun depends upon:
1. Size of orifice disc in handgun.
2. The pressure at the gun.
3. The spraying habits of the gun operator. The whole operation is completely manual so the lay down depends upon how long the operator dwells on a weed patch.

Handgun Orifice Disc Output Capacity

Disc Orifice Size	Capacity L/min at kPa Pressure 500 kPa	1000	1500	2500
4	2.74	3.87	4.74	6.12
5	4.10	5.80	7.10	9.17
6	5.70	8.06	9.87	12.70
7	7.52	10.60	13.0	16.80
8	9.80	13.90	17.0	21.90

Three precautions are suggested when using a handgun:
1. Thoroughly clean the gun between jobs since the hose can contain a substantial amount of pesticide mixture.
2. Precise calibration is very difficult, so handguns should be used for applications where very accurate rates are not required. For example, herbicides are generally applied with a handgun by mixing a very dilute solution and applying to the point of runoff.
3. Pressure and water volume are the factors that allow us to reach the target. For water particles to carry they must have mass, so there are limits to the maximum pressure used to increase the throw or carry of a water stream.
   Always use a large enough hose with nozzle disc to permit using as much pump capacity as possible.

CHEMICAL INJECTORS

Advantages
- — do not contaminate sprayer tank — less cleaning
- — no agitation problems
- — correct chemical rates regardless of spray volume
- — no problem with chemical compatibility in mixes
- — if an operation must stop because of weather or breakdown there is no concern about leaving a chemical solution to settle out in the tank
- — no leftover chemical solution to dispose of.

A few chemical injection systems have appeared in Alberta lately. There were problems encountered with varying viscosities of chemicals causing different flow rates when changes in temperature of the chemicals occurred. The injection system was also not integrated into the sprayer system to allow for automatic rate adjustment when speed changes occurred in the field. PAMI is currently testing an improved version of an injection system.

A more recent arrival operates with a positive displacement piston pump, which may overcome problems encountered with chemical viscosity. The positive displacement pump is ground driven from a trailing wheel on the sprayer. Once the correct setting is made for the desired flow rate the positive displacement ground driven pump will keep the application rate constant regardless of the speed of travel. At present there are no test results to confirm the accuracy of this system.

Flow Meters

Flow meters can be used to measure liquid flow. The flow is a digital readout in litres which can be correlated with speed and distance travelled to determine the application rate. Flow meters should be mounted on the line to measure only the liquid flow to the spray booms or handgun. The bypass flow must not go through the flow meter.

Flow meter

Sprayer Monitors

Electronic calibration is now available from several companies. This is one of the most significant advances in spraying technology. With the use of electronic circuitry, it is possible to correlate liquid flow out of the booms with the forward speed of travel to display the application rate as a continual digital readout. These devices enable selection of the proper application rate and the operator simply adjusts the forward speed until correct application is achieved as indicated on the dial. Liquid flow is continuously measured, so any significant change in the spraying system, such as excessive plugging, pump or regulator malfunction, or excessive leakage will show up instantly on the monitor.

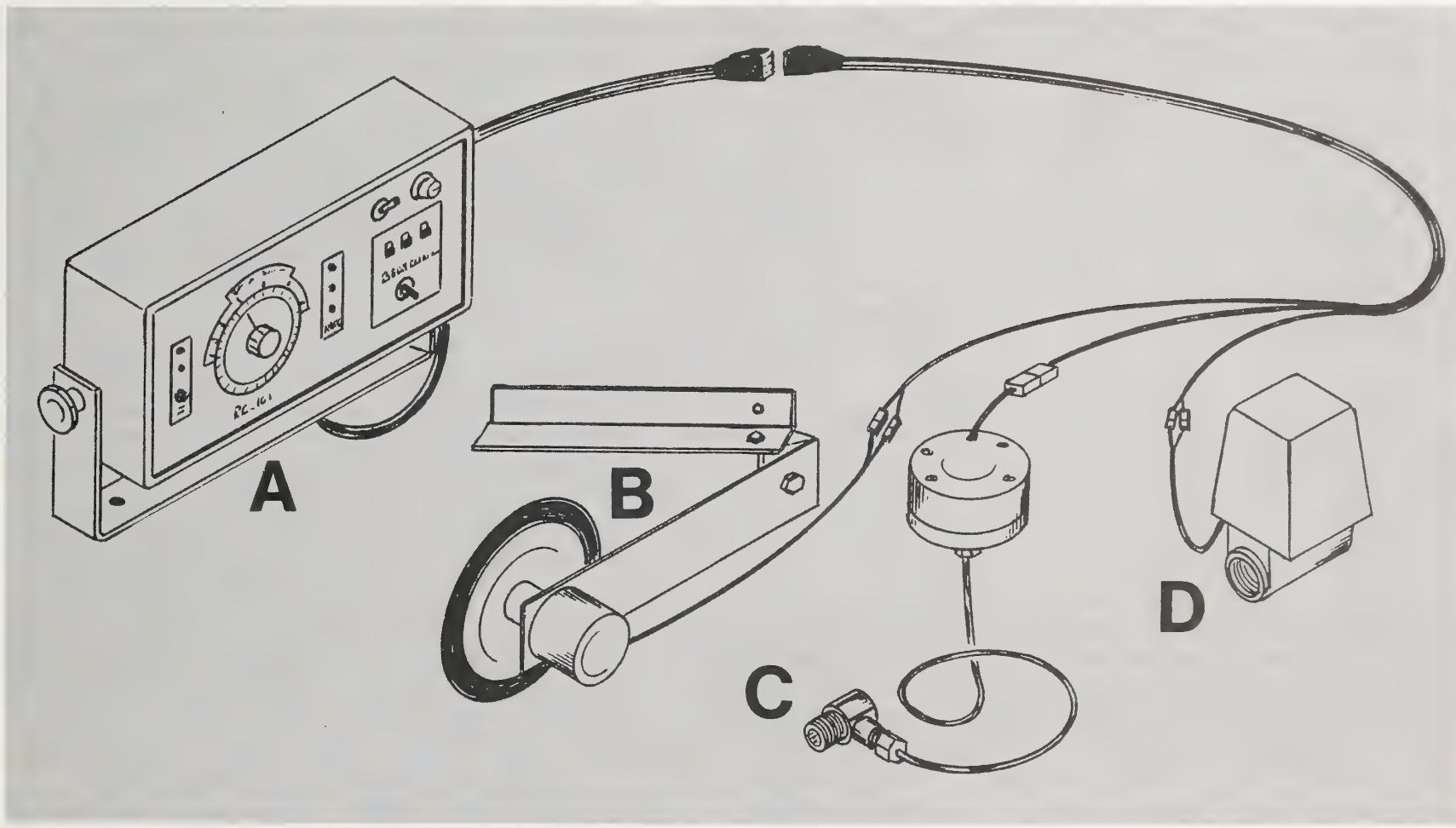
Sprayer monitor

Sprayer Controllers

An automatic sprayer control simplifies your liquid application job by automatically maintaining the same application rate within recommended speed ranges. The system adjusts the liquid flow so the application rate remains uniform throughout the field. The complete system is composed of the four components listed below. The accurate operation of the system is based on having accurate flowing nozzles or tips. Replace tips on a regular basis to assure the system will maintain accurate rate control.

A. Console. The console monitors ground speed and spraying pressure. When the controls are set to the desired speed and rate, an analog computer compares actual ground speed to the preset desired rate and speed and adjusts the spraying pressure to maintain the desired output.
B. Speed Sensor. This sensor is mounted on a non-driven sprayer or tractor wheel; it measures ground speed.
C. Pressure Sensor. This electronic pressure transducer is connected to the nozzle to monitor spraying pressure. The electrical signal is then used to modulate the pressure regulator.
D. Pressure Regulator. This butterfly valve is powered by a gear motor and controls pressure.

It is important to have unrestricted flow through the line, therefore the pump capacity should match the hose diameter size. Too small a hose size will cause either a pressure drop or ineffective operation of the sprayer control system.



Sprayer monitor — controller

SPRAYER OPERATION

Preliminary planning begins with the decision to apply a herbicide and to chose the particular chemical that will be used. You then have three more decisions to make:

— Which speed of travel will you use to apply the chemical? This will depend on the kind of equipment you will use and the roughness of the field you want to spray.
— Which nozzle tips should you use? You pick the nozzle size that will apply the required volume at the speed you wish to travel using the recommended pressure.
— How much chemical should you apply? The chemical label shows the amount of herbicide to apply.

SPRAYER CALIBRATION

Accurate calibration of spraying equipment is an important aspect of chemical usage. An application of more than the recommended rate is wasteful and may damage the crop; applications of less than the recommended rate may be ineffective; again wasteful.

Preliminary Adjustments And Settings

Preliminary adjustments and settings include all of the adjustments that are made when the machine is being prepared for use.

Before starting to spray, check wheel bearings and tire inflation, and lubricate moving parts as recommended in the operator's manual. Tighten any loose bolts or nuts.

Install tips, screens, check valves, and any other equipment that has been selected. Be sure fan nozzles are aligned so patterns overlap slightly but do not interfere with each other.

Boom height depends on the spray angle of the tips selected. Set the boom at the required height and level it from side to side. Improper height causes non-uniform application.

Nozzle Calibration

The output of individual nozzles must be within 5 per cent of the average nozzle output if an even volume is to be applied over the width of the sprayer. Nozzles with outputs either above or below this value must be cleaned and/or replaced.

1. Check and clean all nozzles, screens and filters.
2. Check pressure gauge for accuracy.
3. Check boom pressure with an accurate gauge, and compare to sprayer gauge (both should be identical).
4. With sprayer operating at the desired spraying (boom) pressure, using water only, collect nozzle output for 30 seconds. If ball check valves are used, the pressure should be increased by 35 kPa.
5. Measure and record collected amount.
6. Repeat steps 4 and 5 for all nozzles.
7. Replace nozzles that have an output 5 per cent greater than average; clean and recheck nozzles with outputs of less than 5 per cent of average (replace if necessary).

Brass nozzles should be recalibrated every 25 hours and stainless steel nozzles should be recalibrated every 50 hours. The use of wettable powders will require frequent recalibration of all nozzles.

Ground Speed Determination

Ground speed can be determined by measuring the distance travelled in one minute. Repeat the test several times and average the results. Remember to use the same throttle setting (tachometer) and transmission gear each time. Run the tests in the field to be sprayed and have the sprayer tank half-full. Soil surface and load can affect ground speed and a half-full tank represents the average load. The sprayer must be at full speed before starting the test run.

Speed in km/h	Seconds to Drive 60 metres	Seconds to Drive 90 metres
5.0	45	68
5.5	39	58
6.0	37	54
6.5	34	51
7.0	30	45
8.0	27	41
9.0	24	36
10.0	23	34
11.0	19	29
12.0	18	27
13.0	17	25
14.0	15	23
16.0	14	20

Sample Nozzle Chart

Nozzle	Pressure kPa	Litres Per Min.	Litres per Acre 50 cm Spacing 6km/h	8km/h	9km/h	10km/h
8001 or 11001	275	.38	30	22	20	18
80015 or 110015	275	.57	45	34	30	27
8002 or 11002	275	.76	60	45	40	36

Calibration Procedure I — LITRES PER ACRE

— Field Size _____ Acres
EXAMPLE: 40 acres

— Sprayer Tank Capacity _____ Litres
EXAMPLE: 1400 litres

— Determine Spray Volume _____ Litres Per Acre
EXAMPLE: 40 L/acre
(from label - L/ha x 0.4047) standard spray volume is 40 L/acre

— Calculate spray required for entire field e.g.
40 acres x 40 L/acre = 1600 litres
Note: In this example the tank holds 1400 litres. It will only cover 35 acres.
EXAMPLE:

$$\frac{\text{1400 Litres}}{\text{40 Litres per Acre}} = 35 \text{ acres @ } 40 \text{ L/acre}$$

Therefore a second tank with 200 litres of solution will be needed to complete the remaining 5 acres.

— Select nozzle and speed from "Sample Nozzle Chart"
EXAMPLE: 11002 nozzle at 275 kPa at 9 kmh = 40 L/acre

— Add chemical to water in tank (from label)
EXAMPLE:
1.5 litres per hectare x 0.4047
= 0.607 litres per acre
A tankful will cover 35 acres, therefore multiply 35 x 0.607 = 21.2 litres of chemical
The second tank to complete the field will require:
5 x 0.607 = 3 litres of chemical

— Set pressure at 275 kPa. Drive at 9 kmh. At this speed it takes 36 seconds to travel 90 metres.

Calibration Procedure II

This method of calibration is provided as an alternative.

After the nozzles have been individually calibrated and matched the following steps should be completed.

1. Fill the sprayer tank with water.
2. Operate the sprayer at the desired pressure for 15 minutes.
3. Measure the number of litres needed to refill the tank.
4. Refer to the following table to obtain the correct speed in km/h.

NOTE: Table is correct only for the nozzle spacing indicated.

EXAMPLE: Twenty-six nozzles, 40 L/ac desired, 260 litres needed to refill sprayer. Correct speed — 8 km/h.

CALIBRATION TABLE

To Apply 20 L/ac	To Apply 40 L/ac	NUMBER OF NOZZLES — 50 cm SPACINGS											
LITRES/15 MINUTES		24	25	26	30	32	33	34	35	36	40	48	49
		kilometres per hour											
90	180	6.0	5.8	5.5	4.8	—	—	—	—	—	—	—	—
100	200	6.7	6.4	6.2	5.3	5.0	4.8	—	—	—	—	—	—
110	220	7.3	7.0	6.8	5.9	5.5	5.3	5.2	5.0	4.9	—	—	—
120	240	8.0	7.7	7.4	6.4	6.0	5.8	5.6	5.5	5.3	4.8	—	—
130	260	8.7	8.3	8.0	6.9	6.5	6.3	6.1	5.9	5.8	5.2	—	—
140	280	9.3	9.0	8.6	7.5	7.0	6.8	6.6	6.4	6.2	5.6	—	—
150	300	10.0	9.6	9.2	8.0	7.5	7.3	7.1	6.9	6.7	6.0	5.0	4.9
160	320	10.7	10.2	9.8	8.5	8.0	7.7	7.5	7.3	7.1	6.4	5.3	5.2
170	340	11.3	10.9	10.5	9.1	8.5	8.2	8.0	7.8	7.6	6.8	5.7	5.5
180	360	12.0	11.5	11.1	9.6	9.0	8.7	8.5	8.2	8.0	7.2	6.0	5.9
190	380	—	—	11.7	10.1	9.5	9.2	8.9	8.7	8.4	7.6	6.3	6.2
200	400	—	—	—	10.7	10.1	9.7	9.4	9.2	8.9	8.0	6.7	6.5
210	420	—	—	—	11.2	10.5	10.2	9.9	9.6	9.3	8.4	7.0	6.9
220	440	—	—	—	11.7	11.0	10.7	10.4	10.1	9.8	8.8	7.3	7.2
230	460	—	—	—	—	11.5	11.1	10.8	10.5	10.2	9.2	7.7	7.5
240	480	—	—	—	—	12.0	11.6	11.3	11.0	10.7	9.6	8.0	7.9
250	500	—	—	—	—	—	—	11.8	11.4	11.1	10.0	8.3	8.2
260	520	—	—	—	—	—	—	—	11.9	11.6	10.4	8.7	8.5
270	540	—	—	—	—	—	—	—	—	12.0	10.8	9.0	8.8
280	560	—	—	—	—	—	—	—	—	—	11.2	9.3	9.1
290	580	—	—	—	—	—	—	—	—	—	11.6	9.7	9.5
300	600	—	—	—	—	—	—	—	—	—	12.0	10.0	9.8

Calibration and Application Guide

The following guide is provided to help plan a spraying operation. Included is a formula that can be used to determine spray volume if nozzle output charts are not available.

A. Field description _____

B. Field size _____ acres

C. Crop _____

D. Weeds to control _____

E. Herbicide to use _____

F. Herbicide rate _____ litres or _____ kilograms per acre

G. Spray volume needed _____ litres per acre

H. Total herbicide needed (multiply B x F) _____

I. Sprayer tank size _____ litres

J. Nozzle No. _____

Pressure _____ kPa = _____ litres per acre

Nozzle output _____ L per min

Speed _____ km per hr

K. One tankful will cover (divide I/J) _____ acres

L. Herbicide per tankful (multiply F x K) = _____ L or kg

Formula:

$$\frac{24282 \times \text{L/min (per nozzle)}}{\text{km/h} \times \text{W* (cm)}} = \text{litres/acre}$$

*W — Nozzle spacing (in boom spraying) or spray swath (in boomless spraying) ... in centimetres.

CHANGING RATES

Suppose the application rate you determined is unacceptable. How do you change it? You can make three kinds of changes.

Pressure influences flow rate, as discussed earlier. Lower the pressure and you lower the flow rate. Raise pressure and flow rate is increased. However, this is not a good method to use. You must increase pressure by a factor of 4 to double the flow. High pressure increases the number of small spray particles which can cause drift problems. Pressure too high or too low also distorts nozzle distribution patterns.

Nozzle size can be changed to alter the application rate. Use larger tips to increase the rate. The main advantage of this method over changing the pressure is that using the proper pressure helps to control drift and maintain the nozzle pattern. This is usually the preferred method of changing application rates.

Speed changes alter application rate. This method is practical for small changes in application rate. However, excessive speeds should be avoided for safety reasons. Low speeds increase the time needed to spray a given field. This increases labor costs and ties up equipment for a longer period of time.

LOADING THE SPRAYER

Mixing

Mixing the pesticide thoroughly and carefully is one of the most important steps in good sprayer operation:

— Incomplete mixing results in varied application rates.

— Some chemicals can form invert emulsions if mixed improperly. An invert emulsion is a thick, mayonnaise-like mixture that will not spray properly and is very difficult to clean out of a sprayer.

— The operator is most likely to be exposed to dangerous amounts of pesticide during mixing because he is handling the material in concentrated form. Pesticides can be mixed in the tank or in a premix container. Specific instructions are given on the label of each pesticide. Follow them carefully. Adding chemicals in the wrong sequence can prevent otherwise compatible materials from mixing properly.

To mix some chemicals in the tank, add the pesticide to one-half tank of water. Turn on the agitator and mix thoroughly. Then finish filling the tank with water. For other materials, agitation must be started before adding pesticide and continued until all chemical/water mix has been used.

If a premix container is used, fill it about one-half full of water then add pesticide. Stir the mixture until it is smooth and uniform, then add it to the water in the sprayer tank. Premixing an emulsifiable concentrate with water to form an emulsion, or premixing a wettable powder with water to form a slurry, and then adding these to a partially-filled well-agitated spray tank can help reduce mixing problems with some pesticides.

WETTABLE POWDERS AND FLOWABLES

These formulations are being used by an increasing number of farmers. In some cases, the desired chemicals are only available as wettable powders because of difficulties or expense in making them into liquids. These chemicals are effective, but application takes special equipment and know-how. The newer model sprayers will generally be able to apply these formulations without problem, but older sprayers may require extensive modification.

To ensure adequate agitation to keep the pesticide in suspension, a mechanical or hydraulic agitator must be installed in the sprayer tank. The paddle type mechanical agitation is best, but jet agitators are quite satisfactory if pump output is sufficient to provide 3 to 6 litres/minute per 100 litres of tank size in addition to the requirements for applying the nozzles. Larger tanks will require two or more agitators.

Jet agitators may be equipped with various sizes of orifice discs, depending on the amount of surplus pump capacity. Naturally, the larger orifice sizes provide more agitation, but there is a limit beyond which the pump cannot supply enough pressure. To determine the best size of orifice may require trial and error, although charts are provided with the agitator so that a rough first selection can be made.

To avoid plugging, all strainers in the sprayer system must be the screen or slotted type and not finer than 50 mesh. Powders act as a fine abrasive and rapidly erode brass nozzles.

A special procedure for adding wettable powders to the tank should be followed to ensure that the powder goes into suspension, rather than forming lumps. Start by premixing the material with water in a pail. Half fill the sprayer tank with water and turn on the agitator. Slowly pour the slurry into the tank. If you are making a tank mix, add the other chemicals, then fill the tank and begin spraying. Do not leave wettable powders standing in the tank. Once they settle to the bottom it will be difficult to get them back into suspension.

Without the proper equipment and procedures, farmers should not use wettable powders as the results will be disappointing and the application a source of frustration.

NOTE: Do not confuse wettable powders with soluble powders. Soluble powders truly dissolve in water, they do not remain as a suspended solid. They do not require any special handling, other than a little time and agitation to dissolve them and they will not settle out.

FIELD OPERATION

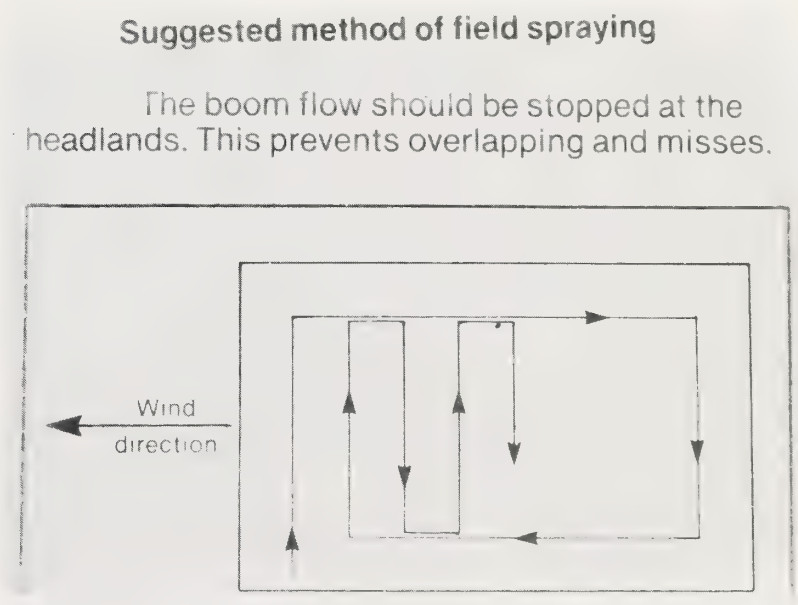
Transport loaded sprayers as short a distance as possible. An accident could spill a load of chemicals on the road or in a ditch, where it could be very hard to contain and cleanup. If agitation of some mixtures is stopped during transport to the field it may be difficult or impossible to obtain adequate remixing.

Pesticide may drift for considerable distances: as a vapor from a volatile chemical, and as fine droplets carried by the wind. Vapor drift can be reduced by using chemicals which do not vaporize easily (amines rather than esters).

Droplet drift may be reduced by spraying during low or no-wind conditions and by the use of proper equipment. Using an accurate pressure gauge, spraying at 275 kPa or less, increasing the volume of water applied, using low-drift nozzle tips and decreasing boom height will all reduce spray drift.

End nozzle use must be limited to fence rows and ditches, and only under no-wind conditions. The spray pattern produced by end nozzles is susceptible to drift.

Misses and overlaps should be avoided. Plugged and worn nozzle tips must be cleaned or replaced. The tractor drawbar should be fixed and not have excessive movement. The boom flow should be stopped at the headlands. This prevents overlapping and misses.



Suggested method

FIELD MARKERS

Field markers are available to aid the operator in preventing misses and overlaps. The disc marker, flag marker, foam marker and spot dye marker and paper marker are commercially available. Operators who have used each method should be consulted prior to purchasing a marker.

Tramlines

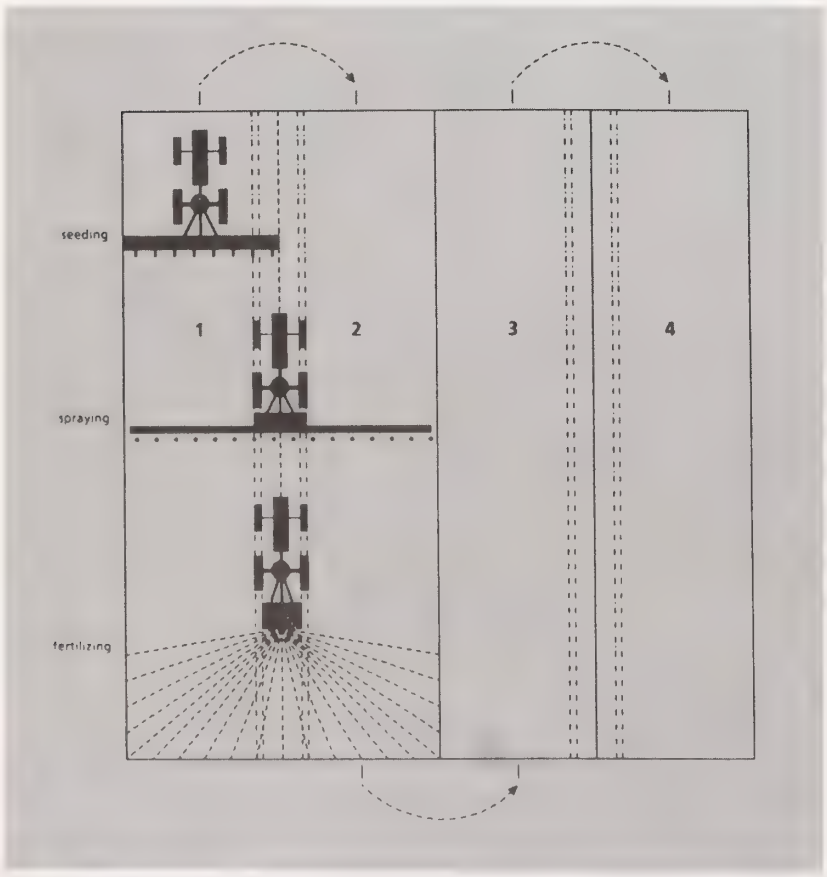
TRAMLINES

Farmers in some European countries use tramlines as a field marking system in cereal and oilseed crops.

The principle of tramlines is to match the working widths of sprayers with that of the seed drill so that spraying operations can be carried out along the tracks laid while seeding. The working width of the seed drill must first be established and then related to the width of the sprayer boom. The boom may need shortening or lengthening so that a multiple of drill passes matches one pass of the sprayer thus enabling the tramlines to be placed at appropriate intervals.

Block a single drill run which is one-half the width of the tractor track from the end of the drill.

This puts in one tramline going up the field and another coming back. This system works well if spraying equipment is twice the width or 4 times the width of the seeder.



Setting up tramlines

Other methods for producing tramlines can be used however the one described is the simplest to implement.

Indications are that any potential yield losses when using tramlines are compensated for as follows:

- — rows that are adjacent to the tramline can draw on extra moisture and soil nutrients and produce more seed.
- — more accurate chemical placement without double coverage or missed strips creates potential for increased yields.
- — trampling from tractor wheels creates some yield loss even if tramlines are not used.

SPRAYER CLEANUP

Proper maintenance of a sprayer will result in longer life and more hours of trouble-free operation. Consult your operator's manual for proper maintenance procedures.

The sprayer should be cleaned at the end of each day of use by flushing the tank, pump and booms with clean water. Remove and clean out filters, screens and nozzle tips.

Plugged tips should be cleaned with a soft brush. Never use your mouth to blow a tip clean.

Cleaning For Storage Or When Changing Chemicals

1. Choose your cleaning area carefully, making sure that discharged cleaning water will not contaminate streams or crops, or be accessible to children and animals.
2. Dilute spray residue by filling the tank with water and circulate through sprayer.
3. Remove all strainers and nozzles and clean thoroughly.
4. Drain the spray solution from tanks, hoses, booms, pumps, and strainers.
5. Rinse the entire system thoroughly with clean water.
6. Fill the sprayer completely with water, circulating it through the entire system.
7. Drain completely.
8. Fill tank with water then add 1 litre of household ammonia per 100 litres of tank capacity.
   0.5 kgs Nutrasol, Solventol or lye, or 1 kg of trisodium phosphate per 100 litres of tank capacity may be used instead of household ammonia.
9. Circulate to ensure that solution contacts all the internal parts of the sprayer.
10. Allow the solution to remain in the tank and hoses overnight.
11. The following day, recirculate the entire system, remove end caps on the booms and then drain completely.
12. Rinse out twice with clean water, recirculating and draining each time.

At Seasons End

1. Add light oil or antifreeze during the final stage of last rinsing to leave a protective coating on all internal parts.
2. Remove pump and store indoors.
3. Close all openings into the sprayer to prevent entry of debris or rodents.

NOTE: All pesticides have specific cleaning recommendations. Refer to product labels for specifics.

CONTAINER RINSING AND DISPOSAL

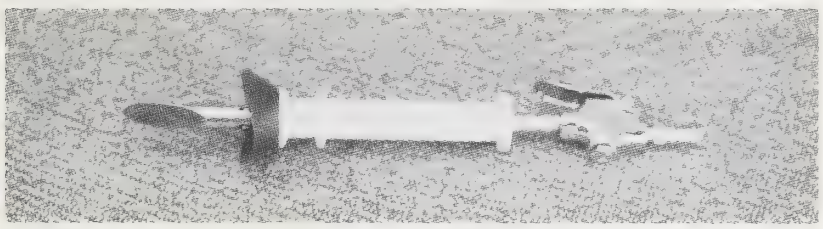
Pesticide containers should be triple-rinsed when being emptied. Studies have shown that applicators may leave up to 15 per cent of a herbicide in a container as it is emptied into the spray tank. A good idea is to instal a T connection on the outlet side of the pump and add a valve and length of garden hose to it to allow for back rinsing of farm chemical pails.

Can Rinsers

Can rinsers are designed for use in both metal cans and plastic jugs. The hose from a water source or from the nurse tank pump is securely attached to the rinser. After ensuring that the valve is on 'off' position insert the sharp piercing end of the rinser into the bottom centre of the inverted metal container or the side wall (near the bottom) of a plastic container. The water under pressure can be turned on and off at your convenience and the leftover pesticide residue is rinsed into the spray tank.

When you use a can rinser there is no need to use the Triple rinsing method of rinsing pesticide containers. A can rinser requires 30 seconds to rinse pesticide containers as compared to five minutes for triple rinsing, saving valuable time.

A rinser renders the containers useless for any future use by puncturing them, and reducing potential health and environmental hazards.



Can rinser

Disposal of empty containers must be done in a safe manner. In Alberta there are centralized sites where all types of pesticide containers are collected for recycling.

DRIFT CONTROL

Spray drift is a major problem to those applying herbicides. Drift can increase the quantity of chemical entering the air and pollutants may damage beneficial insects or harm sensitive crops and gardens.

Kinds Of Spray Drift

Herbicides may reach non-target plants, animals, or humans by wind drifting or by vapors carried in the air. The effect is the same but an understanding of both kinds of drift is required in order to affect control.

Vapor Drift — Vapor drift is the movement of herbicide in the gaseous or vapor state.

The degree to which a herbicide evaporates is determined by the temperature (increases with high temperature) and by the chemical formulation itself. Where possible, low volatile formulations or non-volatile herbicides should be used. With most spraying, the effects of vapor drift will not be seen immediately, but may show up in unrelated areas and it will often be a puzzle as to how the contamination occurred.

Droplet Drift — Droplet drift refers to the wind borne movement of spray particles of very small size. The production of very small particles is a function of the spraying operation, rather than the herbicide itself. The extent of damage depends upon the wind direction, the amount of fine spray droplets, and the susceptibility of the plant or animal which the droplets contact.

Droplet size depends on:

1. nozzle design
2. nozzle size and
3. spraying pressure.

Lower pressure produces larger droplets, while higher pressure tends to produce smaller droplets. High volume nozzles produce larger spray droplets than low volume nozzles.

The height above target is important because it affects the time required for the spray droplets to reach the target, and as a result, the time the droplets can be affected by the wind.

The height at which the nozzles must operate is fixed by nozzle spacing and nozzle design. It is not possible to lower the spray boom below this proper height unless different nozzles are installed.

Using Nozzles To Control Drift

Flat Fan Nozzles — The most common nozzles in use produce a spray pattern of 80°. This feature requires the spray boom to be set at least 40 cm above the target being sprayed to give proper overlapping of spray patterns. Spraying from this height allows wind to affect the spray, causing drift if the droplets are too small.

Nozzles that produce a wide spray pattern enable the spray boom to be set closer to the target, thereby reducing spray drift.

Low Pressure Nozzles — Low pressure nozzles are flat fan nozzles which are specifically designed to operate at low pressures to produce larger droplets. They produce the same spray angle, and liquid distribution at 100 kPa as the standard nozzle at 275 kPa. They can also be used at higher pressure, however, smaller droplets and a wider spray angle will be produced if pressures are increased beyond 100 kPa.

Flooding Fan Nozzles — Flooding fan nozzles have been in use for applying liquid fertilizer. They may be recommended for the application of certain herbicides. Flooding fan nozzles can be used in winds up to 20 km/h with reasonable safety. This is partly due to the larger spray droplets produced by this type of nozzle. The wide angle of spray pattern formed allows the spray boom to be set about 30 cm above the target, thereby reducing the wind effect.

It is essential that the sprayer be equipped with boom wheels to keep the boom ends from contacting the ground.

CAUTION: It is generally accepted that under calm conditions, the uniformity of the pattern produced by flooding fan nozzles is inferior to the pattern produced by regular flat fan nozzles. Flooding nozzles should not be used unless specifically recommended by the herbicide manufacturer.

Raindrop Nozzles — Raindrop nozzles can produce a spray pattern with an angle of 80-100 degrees, depending upon nozzle size and operating pressure. They must be set at 60° to 90° to the vertical in order to obtain a reasonably uniform pattern. They produce larger droplets than the conventional flat fan nozzles. The larger droplets can enable spraying when the wind is too strong for conventional nozzles.

CAUTION: Raindrop nozzles should not be used unless specifically recommended by the herbicide manufacturer.

Angle-Height of Boom — When herbicides are applied for wild oat control, it is recommended that the spray be directed forward at a 45° angle. When the boom is turned to direct the spray forward, it must also be lowered in order to maintain the correct overlapping spray pattern. This form of adjustment may be used for all herbicide applications as similar coverage is obtained, and since the boom is closer to the ground, chemical drift is reduced. The distance the spray droplets must travel is the same, regardless of whether the boom is turned 45° and lowered or left higher and turned vertically. The difference is that wind velocity is always lower nearer the ground.

Using Foams For Drift Control

Special techniques have been developed to help overcome the problem of spray drift. Some of these techniques include the use of additives that are designed to change the chemical solution to a foam-like substance when added to the spray tank. However, in order to make use of some of these additives, major changes to the sprayer may be required.

CAUTION: These additives may alter the activity of some herbicides, especially where thorough coverage is required. Do not use unless recommended for use with the herbicide.

(a) Invert Emulsions — Invert emulsions are formed when a small amount of water is mixed into a chemical/oil solution. A thick, mayonnaise-like emulsion forms at the nozzle. This emulsion is sprayed out of special nozzles. The sprayer would also require some expensive alterations.

(b) Thickening Agents — A thickening agent is added to the spray mix in the tank and produces a jelly-like spray solution. A centrifugal or piston pump is required for effective use.

(c) Particulating Agents — A particulating agent is injected into the spray mix in the tank and produces large particles containing the herbicide at the nozzle. No special equipment, other than the injector, is required. However, considerable care is required to apply this spray because temperature and acidity of the water will affect the proper formation of the large particles at the nozzle.

A product commonly used for drift control in industrial spraying operations is NALCO-TROL. It is not recommended for on-farm use.

IMPORTANT: Never add water to the NALCO-TROL container.

Shake NALCO-TROL container well. Always add wettable powder herbicides **before** NALCO-TROL and assure dispersion prior to NALCO-TROL addition. For liquid herbicides NALCO-TROL should be added **first** and mixed for 10 minutes prior to the herbicide addition. The measured amount of NALCO-TROL should be added as a pencil-thin stream to the agitating tank mix or for tanks with weak agitation to the surface agitation created during the tank filling operation.

Continue to agitate mix tank for at least 5 minutes before use.

Application Uniformity Versus Drift

The objective of pesticide spraying is to control a problem (weed, insect, fungus). Choosing the correct chemical is half of the solution; applying that chemical uniformly at the desired rate is the other half.

Selecting the correct chemicals is not a problem when using the guidelines and information published by the chemical companies, the various government and university agencies.

However, a problem does exist when attempting to apply the chemical uniformly and without drift. Even with today's technology this is impossible. We must therefore compromise between uniformity and some drift.

The following table illustrates that the 8002 and 8002LP tips produce the most uniform pattern and the least drift. Since the 8002LP (at 100 kPa) may not be suitable for some herbicide applications the 8002 tip would be a good choice.

By increasing the volume of water applied the drift is substantially reduced (compare 650067 and 65015). Combining the effects of increased water volume with the supe-

Nozzle Tip Drift Comparison

Spray Rig	Nozzle Tip	Pressure kPa	cv (%)*	Target Deposit Average Droplet Size (um)**	Relative Drift*** (20 km/h wind)
Ground	650067	275	27	390	7
Ground	65015	275	23	550	3.5
Ground	8002	210	19	650	2
Ground	8002LP	100	21	860	1
Ground	TK.75	275	28	390	3
Spray Coupe	730077	275	28	250	19
Pawnee***	D4-45	170	35	200	25 at 10 km/h
Agwagon****	D4-45	170	46	200	49 at 10 km/h
Pawnee****	D10-45	170	42	300	14 at 10 km/h
Agwagon ****	D10-45	170	46	220	43 at 10 km/h

* The cv (coefficient of variation) is a measure of pattern uniformity. The lower the cv, the better the pattern uniformity. A cv of 20 - 25% may be acceptable but a cv below 20% is desirable.

** Average droplet size implies that 50% of the droplets are larger than this figure and 50% are smaller. (1000 um = 1 mm).

*** Relative drift is the drift of a tip in relation to the tip with the least drift (i.e. 1). For example, the 650067 tip has 7 times the drift of the 8002LP. The drift was measured 5 metres downwind from the edge of the swath.

**** Aircraft.

rior performance of the 80 tips the best compromise of uniform deposits and reduced drift is achieved.

The TK.75 tip, commonly used with wild oat chemicals, has poor uniformity and medium drift control characteristics. These factors limit flooding tip use to only those chemicals which specify them.

The table also provides a comparison of other application methods in use, i.e. the "Spray Coupe" and aircraft.

TROUBLESHOOTING

Sprayers fail to operate correctly because of breakage, corrosion, abrasion or pumps that run dry. Avoid breakage by selecting good equipment, operating carefully, and maintaining properly.

Here are some of the more common problems that can occur with sprayers. Possible causes and remedies are included.

Problem	Possible Cause	Remedy
Loss of pressure	1. Pressure regulator improperly adjusted or stuck open.	1. Clean and adjust pressure regulator.
	2. Suction screen plugged.	2. Thoroughly clean screen.
	3. Cracked or porous suction hose.	3. Replace hose.
	4. Worn pump.	4. Replace or recondition pump according to the manufacturer's instructions.
	5. Worn nozzle tips.	5. Replace nozzle tips.
	6. Faulty gauge.	6. Replace gauge.
	7. Pump starving.	7. Check for collapsed suction hose, plugged filter, main control valve too small or wrong type.
Excessive pressure	1. Pressure regulator improperly set or stuck.	1. Adjust pressure regulator.
	2. Bypass hose plugged or too small.	2. Unplug the hose or replace it with a larger one.
	3. Faulty gauge.	3. Replace gauge.
Pressure gauge needle jumps excessively.	1. Gauge too sensitive.	1. Replace gauge or mount a flow regulator between the gauge and the pump.
	2. Pump starving.	2. Check for restriction on inlet side of pump.
Nozzles plugging	1. Too fine a nozzle screen or the screen is corroded.	1. Replace with the proper mesh screen or clean the screen thoroughly.
	2. Dirty water or foreign material in the tank.	2. Drain tank and clean thoroughly; check suction screen for holes.
	3. Chemical (wettable powder) not properly mixed.	3. Increase agitation.
	4. Nozzles too small.	4. Replace with the proper nozzles for the chemical being used.
	5. Boom filled with foreign material.	5. Remove the plugs in the ends of the boom section to clean the boom.
Poor spray patterns	1. Booms too low.	1. Raise boom, or rotate ahead or back slightly.
	2. Pressure too low.	2. Check pressure on boom end with a gauge. Presure should be within 10 to 15 kPa of main gauge. If not, check sizes of fittings and hoses for restrictions.
	3. Nozzles worn or damaged.	3. Replace nozzles.
Uneven spray pattern from nozzle.	1. Nozzle screen plugged.	1. Clean or replace screen.
	2. Nozzle tip damaged.	2. Replace tip with new one.
Visible spray drift	1. Spray too fine.	1. Cut pressure down, use larger nozzles.
	2. Boom set too high.	2. Lower boom and angle forward or back.
	3. Too windy.	3. Quit spraying.
Booms swinging	1. Loose hitch between sprayer and tractor.	1. Tighten hitch or use ball type hitch.
	2. No braces.	2. Install horizontal braces on boom.
Booms moving up and down	1. No boom wheels.	1. Install boom wheels.
	2. Rough field.	2. Slow down.

WARNING: The tank filler hose should be supplied with an automatic shut off and check valve to prevent the tank solution from siphoning into the water supply when the pump has been shut off. If siphoning should occur, the water supply would be unfit for ANY use.

GRANULAR APPLICATION

APPLICATION AND CALIBRATION

Granular herbicides, not unlike liquids, are required to be applied accurately and uniformly on the entire field. Granular herbicides do not diffuse more than ⅓ inch in the soil. If they are not applied uniformly this can lead to areas of no control and other areas where the crop is injured.

The rate of application is critical to the extent that an underapplication of 20 per cent can lead to only 50 per cent control. Also an overapplication by 20 per cent can become fairly expensive not only in dollars paid for the herbicide, but because overapplication causes residues to persist into the following year causing crop injury.

A wide variety of granular applicators is available on the market today. Gravity and pneumatic applicators in implement-mount, skid-mount and pull-type trailer models are common. Some can be mounted on tillage equipment up to 70 feet wide. Some have electronic monitoring devices and some are available with automatic electronic rate controllers. Pneumatic applicators seem to be taking over from the gravity type machines, especially the implement-mounted type for wide, multi-winged, tillage equipment. Rental agencies and custom applicators utilize trailer-type and skid-mount pneumatic applicators almost exclusively.

Pull type gravity applicator

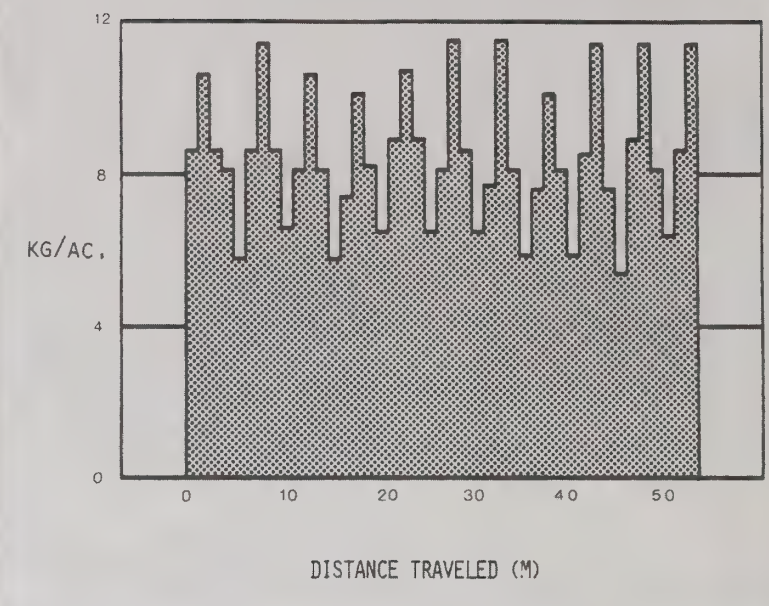
According to testing done by PAMI the pneumatic applicators provide a fairly uniform and accurate distribution of granular herbicides provided they are assembled, calibrated and operated correctly.

Some gravity type machines tested did not provide a very uniform distribution of granules, particularly on rough or hilly fields. Also, surging in application rates in the direction of travel occurred with some gravity type applicators. The surging in application rate occurred because of the feed screw moving across the opening in the metering mechanism.

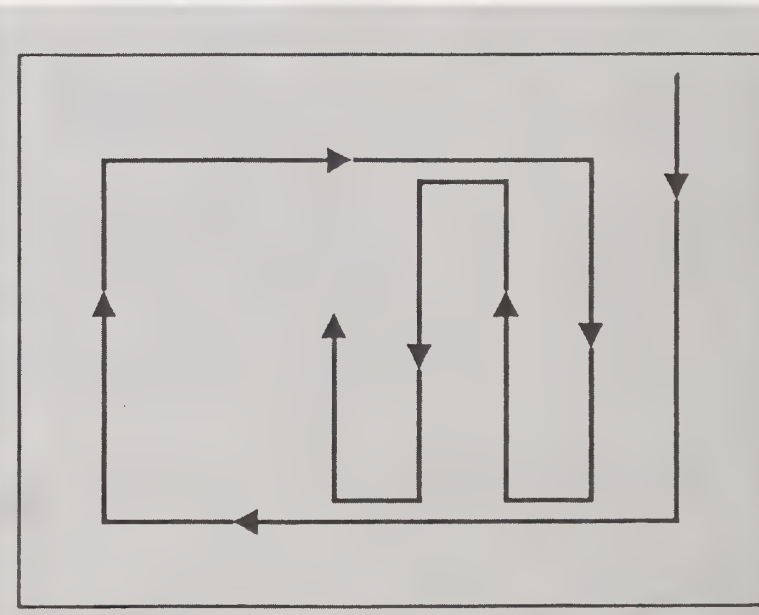
To prevent herbicide residue buildup and crop injury, the following diagram is provided as a suggested method to use when applying herbicides.

Make one or two passes around the perimeter of the field, then travel up and down the field shutting off the herbicide applicator while turning around in the field perimeter.

Typical distribution of Avadex BW granules below one discharge opening in the direction of travel.



Application uniformity

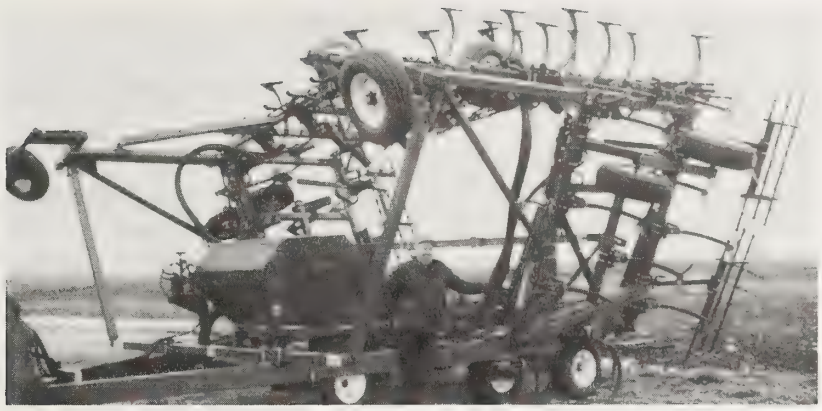


Suggested method for herbicide application

Regardless of which type of granular applicator is used there are some constant "Do's and Don'ts" to keep in mind to achieve as uniform an application as possible. Keep in mind that even the most thorough incorporationg job will not improve a poor job of applying the herbicide.

It is generally agreed that the most efficient method of applying granular herbicide is with an applicator mounted on a tillage implement. It saves money by providing application and incorporation in one trip over the field and it also provides an accurate marker system to avoid doubling over a treated area.

A marker system is important in any herbicide application, but it can be critical when applying residual granular herbicides that are commonly used. For example a two foot overlap using a 40 foot machine will cause 5 per cent of a field to be covered twice. If a product costs $13 per acre at the recommended rate, a waste of 65 cents per acre oc-



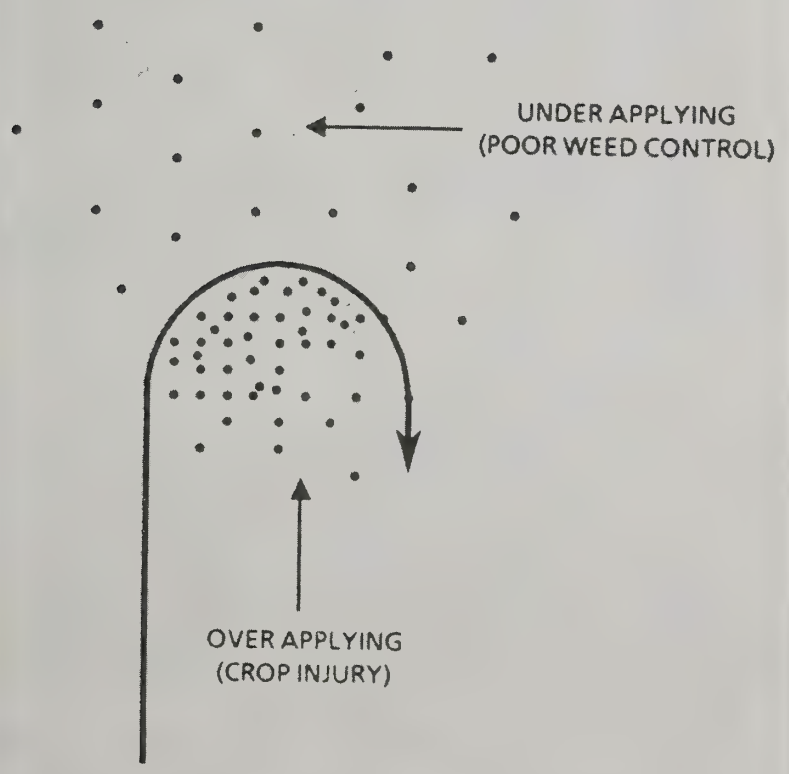
Pneumatic applicator — implement mounted

curs. Add to this the yield reduction in the current year plus damage to the crop the following year because of residue carry over.

Trailer-type and skid-mounted applicators have marking systems available as options. Markers include foam types, paint markers and disc markers, however, many rental units do not have any marker system.

All herbicide applicators must be shut off while turning to prevent erratic application on field perimeters. If the applicator is not shut off on turns the area on the inside of the turn will receive a heavy dose of herbicide because that portion of the applicator will be almost standing still. The area being covered by the outside portion of the applicator will receive much less herbicide than is required. This will result in some areas of crop damage and other areas of no weed control.

Typical uneven distribution obtained when applicator is not shut off when cornering.



Typical uneven distribution

A continuous check on the calibration of all granular applicators is necessary because flowability of granules changes with temperature and humidity. High temperature and/or humidity cause granules to become sticky and not flow uniformly. Granular herbicides should be stored in a cool and dry place out of the sunlight. They should never be left in the hopper overnight as moisture can cause the granules to form a crust and plug the metering devices. Leftover chemical should always be removed from the entire system. Granular herbicides should be screened to separate out lumpy herbicide which would affect metering. The lid on hopper boxes must be kept closed to prevent moisture or debris from entering.

The following checklist summarizes the maintenance activities necessary to obtain the best results and durability from airflow granular applicators:

1. Inspect and clean — hopper bottom, feed metering rollers, venturies and hoses should be checked at least once daily to ensure that they are free of moisture, dust, chaff, stones, etc.
2. Airflow hoses — check daily for wear. Turn hoses 90° yearly, to extend life.
3. Lubricate — grease all moving parts frequently.
4. Electric clutch/metering drive/feed metering system — check daily for proper operation. Ensure that all components of the metering assembly are tight and in line.
5. Fan Inlet — ensure that it is free and clear of all obstructions.
6. Fan Belt — check for wear.
7. Ground drive only — check tire pressure as it can affect rate of application.
8. Fan Drives —
   (a) Auxiliary gas engines — check oil and air filter daily. Ensure fan speed of 3,000 to 3,600 rpm.
   (b) PTO Drive (NODET®) — operate with 540 or 1,000** rpm PTO, (**1,000 rpm PTO requires adapter kit), to produce a fan speed of 3,600 to 4,000 rpm.
   (c) Hydraulic Motor —

Applicator Model	Tractor Hydraulic Flow	Fan Speed
Beline COMPUTAIRE®	10 gpm	2,900 rpm
Gandy AIR-SPEED®	8 gpm	4,000 rpm
Valmar AIRFLOW®	10 - 12 gpm	3,000 - 3,600 rpm

9. Wet Equipment — after heavy dew or rain clean hopper bottom and feed metering rollers and run fan about 15 minutes to dry out hoses and venturi system.
10. Outlet uniformity — before loading hopper, inspect for obstruction in the airflow system by checking air velocity at all outlets.
11. Marking system — for trailer type or truck mounted applicators, especially in stubble conditions, a sturdy disc-type marker or a properly operating foam marker is necessary for accurate application.
12. Hopper screen — be sure to load product through the hopper screen to prevent foreign material (paper, dirt, straw, etc.) from entering and plugging or damaging the metering system.
13. Application delays — to prevent moisture absorption and caking, avoid letting product remain in the applicator overnight or for other prolonged periods of time, especially during high temperatures and excessive moisture.

14. Calibrate — frequent calibration is necessary to ensure accurate and consistent rates of application. Rate charts and calibration instructions are available from the applicator manufacturer.

Calibration

Correct calibration of granular applicators is essential for accurate herbicide application. The operator's manual for each granular applicator contains information on procedures to follow for correct calibration settings and how to check the calibration. When renting an applicator ensure that an operator's manual is made available. It is critical that granular applicators are calibrated for the particular granule size to be applied. When renting a unit this is extremely important as the previous renter may have calibrated it for some other product.

1. Fill the hopper(s) to a pre-determined level.
2. Treat an area of known dimension.
3. Weigh a full bag.
4. Refill the hopper(s) from the bag to the original level in the applicator.
5. Weigh the remainder left in the bag.
6. Calculate the amount used by subtracting the weight of the remainder from the weight of the full bag.
7. Divide this by the area treated to determine the rate per acre.
8. Adjust the gauge setting if necessary.

Preparing For Storage

— vacuum or blow out the applicator.
— cover with tarp, don't store in direct sunlight.
— remove chains, metering devices and control boxes and store indoors.
— cover electric clutches with a plastic bag.

EQUIPMENT SETTINGS FOR RIVAL 10G

The following equipment guidelines should only be used as starting points for equipment calibration. All applicators should be calibrated each time they are used in order to avoid costly misapplications.

Applicator	Broadcast Rate kg/acre	Applicator	
		Sprocket on Meter Fee Screw	Sprocket on Counter Shaft
Barber Spreader Use chemical screw (and 18 tooth 2050 chain sprocket) on counter shaft (small feed screw)	3.4	14	6
	4.4	10	6
	5.6	10	8
	6.8	10	10
Beline CC-5 Computer Control	3.4	9.2	
	4.4	11.8	
	5.6	15.0	
	6.8	18.2	

		Speed km/h					
		5	6	7	8	9	10
Gandy Broadcast (Drip) Applicator S902 13 cm Spacing	3.4	8	8	9	10	10	11
	4.4	9	9	10	11	11	12
	5.6	10	11	11	12	13	14
	6.8	11	12	13	14	15	15

		Speed km/h					
		5	6	7	8	9	10
Gandy Broadcast (Drip) Applicator S902 18 cm Spacing	3.4	9	10	11	11	12	13
	4.4	10	11	12	13	14	15
	5.6	11	13	14	15	16	17
	6.8	13	14	15	16	17	18

		Speed km/h					
		5	6	7	8	9	10
Gandy Air-Sped 61 cm	3.4	16	18	20	21	22	23
	4.4	19	21	22	23	25	26
	5.6	21	23	25	26	28	30
	6.8	23	25	27	29	31	32

Above settings are recommended for each broadcast rate.

		Speed km/h					
		5	6	7	8	9	10
Gandy Air-Sped 69 cm Spacing	3.4	23	26	27	29	31	32
	4.4	26	29	31	33	35	36
	5.6	30	32	34	36	38	40
	6.8	32	35	37	39	41	43

The above settings are recommended for each broadcast rate.

		Speed km/h					
Gandy Air-Spred 76 cm Spacing		5	6	7	8	9	10
	3.4	24	27	29	31	32	34
	4.4	28	30	32	34	36	37
	5.6	31	34	36	38	40	41
	6.8	34	36	39	41	43	45
		The above settings are recommended for each broadcast rate.					

		Nodet Settings
Nodet Gougis Model MT 12	3.4	A1 - B4 - C6 - D5
	4.4	A2 - B3 - C5 - D6
	5.6	A2 - B3 - C7 - D5
	6.8	A3 - B2 - C5 - D6

		Drive Gear Ratio	Valmar Setting
Valmar Airflow	3.4	Low	B3
Truck Mount (240)	4.4	Low	B4
Trailer Mount (240)	5.6	Medium	B2
Implement Mount (240,320)	6.8	Medium	B3

Low Gear Ratio: Use combination sprocket with 15 tooth gear on drive side and 30 tooth gear on driven side.
Medium Gear Ratio: Use combination sprocket with 30 tooth gear on both drive and driven sides.

EQUIPMENT SETTINGS FOR TREFLAN Q.R. 5

These are guidelines to be used as starting points for equipment calibration only.

		Kilograms Per Acre		
		9	11	14
Applicator	**Speed km/h**	**Meter Setting**	**Meter Setting**	**Meter Setting**
Beline Linear Control (calibrate each hopper)	6.4	40	50	60
	7.2	45	56	68
	8.0	50	62	75
	8.8	55	69	83
	9.6	60	75	90
	10.4	65	81	98
	11.2	70	88	105
Gandy Boxes (calibrate each hopper)		**Gauge Setting**	**Gauge Setting**	**Gauge Setting**
	6.4	10	10.9	12
	8.0	11	12	13
	9.6	11.5	13	14
	11.2	12.5	14	15.5
Gandy Air-Spred 61 cm spacing	6.4	21	23	25
	8.0	23	26	28
	9.6	26	28	31
	11.2	27	30	34
Gandy Air-Spred 68 cm spacing	6.4	22	25	27
	8.0	25	27	30
	9.6	27	30	33
	11.2	29	32	35
Gandy Air-Spred 76 cm spacing	6.4	23	26	28
	8.0	26	29	31
	9.6	28	31	35
	11.2	30	35	—

Granular Applicator Settings For Treflan Q.R.5

Valmar Airflow

Application Rate	Ratio	Range	Gear
9 kg/acre	Medium	B	2
11 kg/acre	Medium	B	3
14 kg/acre	Medium	B	4

Nodet 40

Application Rate	Sprocket Setting			
	A	B	C	D
9 kg/acre	2	3	5	7
11 kg/acre	2	3	7	5
14 kg/acre	2	3	6	5

EQUIPMENT SETTINGS FOR HERITAGE

These guidelines to be used as starting points for calibration only.

BELINE LINEAR III

Calibrate Each Hopper

Speed (km/h)	6.4			7.2			8.0			8.8		
kg/acre	6.5	7.6	9	6.5	7.6	9	6.5	7.6	9	6.5	7.6	9
Meter Setting	27	32	36	31	37	41	34	40	45	38	44	50
Speed (km/h)	9.6			10.4			11.2					
kg/acre	6.5	7.6	9	6.5	7.6	9	6.5	7.6	9			
Meter Setting	41	48	55	44	52	59	48	56	64			

GANDY BOXES

Calibrate Each Hopper

Speed (km/h)	6.4			8.0			9.6			11.2		
kg/acre	6.5	7.6	9	6.5	7.6	9	6.5	7.6	9	6.5	7.6	9
Gauge Setting	8	8.5	9	8.5	9.3	10	9.5	10	10.5	10	10.7	11.5

GANDY AIR SPRED

	6 km/h			8.0 km/h			9.6 km/h		
kg/acre	6.5	7.6	9	6.5	7.6	9	6.5	7.6	9
(61 cm Spacing) Gauge Setting	15	16	17	17	18	19	18	20	21
(68 cm Spacing) Gauge Setting	16	17	18	17	19	20	19	21	22
(76 cm Spacing) Gauge Setting	16	18	19	18	20	21	20	22	23

VALMAR AIRFLOW

Kilograms Per Acre	Ratio	Range	Gear
4.5	Low	B	2
6.5	Low	A	3
7.6	Low	B	4
9.0	Low	B	5

At high temperatures the product HERITAGE® may stick to the feed rollers causing a 10-18 per cent decline in application rate.

NODET 40

Kilograms Per Acre	Sprocket Setting A	B	C	D	Actual Amount Applied
4.5	1	4	5	7	4.8 kg/ac
6.5	1	4	5	7	6.9 kg/ac
7.6	1	4	7	5	7.9 kg/ac
9.0	1	4	6	5	9.0 kg/ac

*Remove #3 and #4 gears from hidden gear box and replace with #2 gear on top and #8 gear on bottom.

EQUIPMENT SETTINGS FOR AVADEX BW

Guide Settings For Gandy Air-Sped Granular Applicators To Apply Avadex BW

Gauge Setting	kg/acre (61 cm Spacing) 6.4 km/h	8.0 km/h	9.6 km/h	11.2 km/h	12.8 km/h	14.4 km/h	16 km/h
25	5.3						
26	5.8						
27	6.3	5.1					
28	6.8	5.5					
29	7.4	5.9					
30	7.9	6.3	5.3				
31		6.8	5.7				
32		7.4	6.2	5.3			
33		7.9	6.6	5.6			
34			7.0	6.1	5.3		
35			7.5	6.5	5.6		
36			8.0	6.8	6.0	5.3	
37				7.3	6.3	5.6	
38				7.6	6.7	6.0	5.3
39				8.0	7.0	6.3	5.6
40					7.4	6.5	6.0
45					9.9	8.8	7.9

Guide Settings For Gandy Air-Spred Granular Applicators To Apply Avadex BW

Gauge Setting	Kilograms Per Acre @ 68 cm Spacing 6.4 km/h	8.0 km/h	9.6 km/h	11.2 km/h	12.8 km/h	14.4 km/h	16 km/h
25	—						
26	5.2						
27	5.7						
28	6.1						
29	6.5	5.2					
30	7.0	5.6					
31	7.6	6.1	5.1				
32	8.2	6.6	5.5				
33		7.1	5.9				
34		7.5	6.3	5.4			
35		8.0	6.7	5.7			
36			7.1	6.1	5.3		
37			7.5	6.4	5.6		
38			7.9	6.8	5.9	5.2	
39				7.1	6.2	5.5	
40				7.5	6.5	5.8	5.2
45				10.0	8.8	7.8	7.0
50							8.9

Guide Settings For Gandy Air-Spred Granular Applicators To Apply Avadex BW

Gauge Setting	Kilograms Per Acre @ 76 cm Spacing						
	6.4 km/h	8.0 km/h	9.6 km/h	11.2 km/h	12.8 km/h	14.4 km/h	16 km/h
27	5.1						
28	5.5						
29	5.9						
30	6.3	5.0					
31	6.8	5.5					
32	7.4	5.9					
33	7.9	6.3	5.3				
34		6.8	5.7				
35		7.2	6.0	5.2			
36		7.7	6.4	5.5			
37		8.1	6.8	5.8			
38			7.1	6.1	5.3		
39			7.5	6.4	5.6	5.0	
40			7.8	6.7	5.9	5.2	4.7
45				9.1	7.9	7.1	5.7
50						8.9	8.0

Guide Settings For Beline Granular Applicators To Apply Avadex BW

Kilograms Per Acre — Speed km/h							Meter Set Point
6.4	7.2	8.0	8.9	9.6	10.5	11.2	
4.0							36
4.5	4.0						40
5.0	4.5	4.0					45
5.6	4.9	4.5	4.0				49
6.0	5.4	4.8	4.4	4.0			54
7.0	5.8	5.3	4.8	4.4	4.0		58
7.6	6.3	5.7	5.1	4.7	4.4	4.0	63
8.0	6.8	6.1	5.5	5.1	4.7	4.3	67
8.6	7.2	6.5	5.9	5.4	5.0	4.6	71
8.9	7.6	6.9	6.3	5.7	5.3	4.9	76
	8.1	7.3	6.6	6.1	5.6	5.2	80
	8.5	7.7	7.0	6.4	5.9	5.5	85
	9.0	8.1	7.4	6.8	6.2	5.8	89
		8.5	7.7	7.1	6.5	6.1	94
		8.9	8.1	7.4	6.8	6.4	98

Guide Settings For Valmar Granular Applicators To Apply Avadex BW

Kilograms Per Acre — Gear Box Setting										Drive Gear Ratio
No.1		No.2		No.3		No.4		No.5		
B	A	B	A	B	A	B	A	B	A	
1.9	2.0	2.3	2.5	2.8	3.1	3.4	3.8	4.2		Low Ratio - Use combination sprocket with 15 tooth gear on drive and 30 tooth gear on driven side.
3.7	4.1	4.6	5.1	5.6	6.3	6.9	7.7	8.4		Medium Ratio - Use combination sprocket with 30 tooth gear on drive and 30 tooth gear on driven side.
7.5	8.2	9.2	10	11.3	12.5	13.8	15.5	16.9		High Ratio - Use combination sprocket with 30 tooth gear on drive and 15 tooth gear on driven side.

Guide Settings For Nodet Granular Applicators To Apply Avadex BW

Sprocket Settings				Kilograms Per Acre
A	B	C	D	
2	3	5	6	4.3
2	3	5	7	4.9
2	3	7	5	5.7
2	3	6	5	6.3
3	2	5	6	7.3
3	2	5	7	8.3
3	2	7	5	9.5
3	2	6	5	10.8

SOIL INCORPORATION

Soil applied herbicides have varying requirements as to depth of incorporation. The crop being grown, the weeds to be controlled, and the herbicide being used dictate just how deep the incorporation must be to achieve maximum weed control with minimum crop damage. For example, trifluralin is incorporated to a depth of 10 cm to control wild oats in a canola crop but is only incorporated to a depth of 4 cm when used to control green foxtail in cereals. If the trifluralin were incorporated deeper than 4 cm in the case of cereals the crop would be severely damaged and the herbicide concentration would be diluted in the soil profile providing poor green foxtail control.

For the above reasons it is especially important that any granular herbicide which calls for a shallow incorporation should not be applied to lumpy soil as the granules may drop between the lumps deeper than required, whereas a liquid spray is attached to the soil particles. If granules are to be used on this type of soil it will be necessary to prework the soil and bring it into the necessary condition, free of large lumps, before applying the herbicide. If this soil condition requires several operations to achieve the proper soil condition for good incorporation of the granular herbicide, it can lead to drying out the soil, as well as create a situation where the soil would be subject to wind and water erosion. Therefore, if the recommended incorporation procedure increases the erosion potential, an alternate herbicide or weed control method should be considered.

High levels of crop residue or plant growth on the soil surface affect the activity of soil-incorporated liquid herbicides because of the herbicide being absorbed by the trash. A general recommendation is to reduce crop residue and plant growth in stubble fields so that two-thirds of the soil surface is visible before applying a liquid soil incorporated herbicide. In areas where soil drifting may be a problem, excessive cultivation to prepare the soil for a liquid herbicide should be avoided.

Granular soil-incorporated herbicides were introduced to improve herbicide performance in situations where there were large amounts of straw on the soil. Granules can be applied directly to stubble before tillage operations, providing there is not too much straw or chaff to impede uniform incorporation of the herbicide. As fewer workings of the soil leave more crop residue to prevent soil drifting, the granular herbicide is recommended over the liquid.

A wide variety of tillage equipment may be used for incorporation of granular herbicides. The choice depends on availability of equipment, the soil condition, soil erosion potential, and required depth of incorporation.

Disc type implements generally provide deeper incorporation, more soil breakdown, and more uniform mixing to the depth of tillage than most other implements. This type of implement would be used where deep incorporation is needed, and where the soil is sticky or lumpy. However, where two passes are recommended for thorough and uniform herbicide distribution, and the area is subject to soil drifting, perhaps another choice in equipment would be more suitable.

Cultivators tend to give shallower incorporation than disc implements. Cultivators with rigid shanks, wide shank spacing, and low lift sweeps can be expected to provide poor uniformity of incorporation and uneven depth, especially at slower speeds. Cultivators with flexible shanks, narrow shank spacing and high lift sweeps provide more uniform incorporation when used at high speeds of travel. However, the incorporation is shallower.

Harrows are used for shallow incorporation but soil must be loose or else incorporation will be too shallow. Tine harrows behind cultivators tend to provide more mixing than drag harrows owing to the movement of the tines. Rotary or oscillating harrows are more effective in heavier trash conditions as they do not tend to plug up.

In general, increased speed of operation will improve soil mixing and at the same time increase the risk of soil erosion.

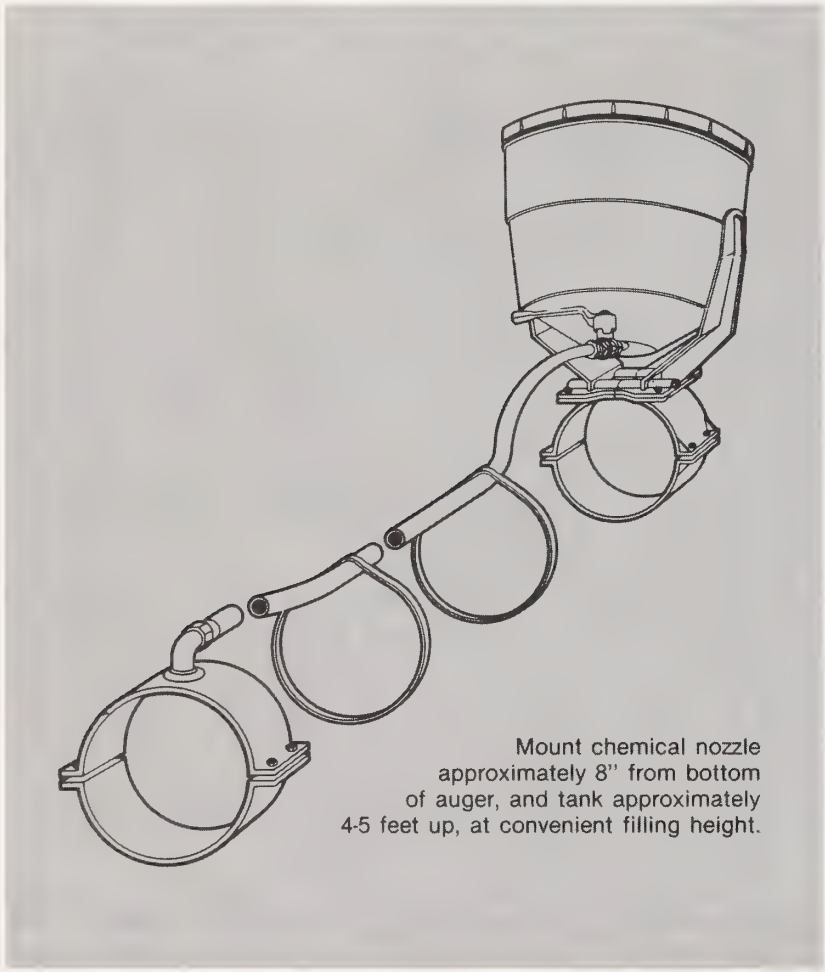
Rod weeders and other wide blade implements do not provide good incorporation of soil-applied herbicides because very little soil is disturbed and most of the granules are left on or near the surface.

Although there are many factors to consider when selecting a method for incorporating soil-applied herbicides, close attention must be paid to herbicide label recommendations concerning application and incorporation techniques. A careful check on soil conditions is needed to avoid drying out the soil and to avoid increasing the potential for soil erosion. Cultivated soil that is likely to dry out should be harrowed and packed after any tillage operation, be it spring or fall.

Reading and following label instructions will ensure best results unless conditions are extreme.

SEED TREATMENT APPLICATORS

A range of equipment is being used for applying liquid seed treatment chemicals. Simple drip type applicators are the most common methods used for liquid formulations, however they are difficult to calibrate accurately. Because drip-type applicators depend on gravity to operate the rate of flow changes when the level of liquid in the container changes thus necessitating adjustments to compensate for the changed flow rate. Temperature changes affect the viscosity of liquid chemicals causing them to flow at a slower rate when cold and a higher rate when warm thereby making it difficult to maintain a constant flow with gravity-type drip applicators.



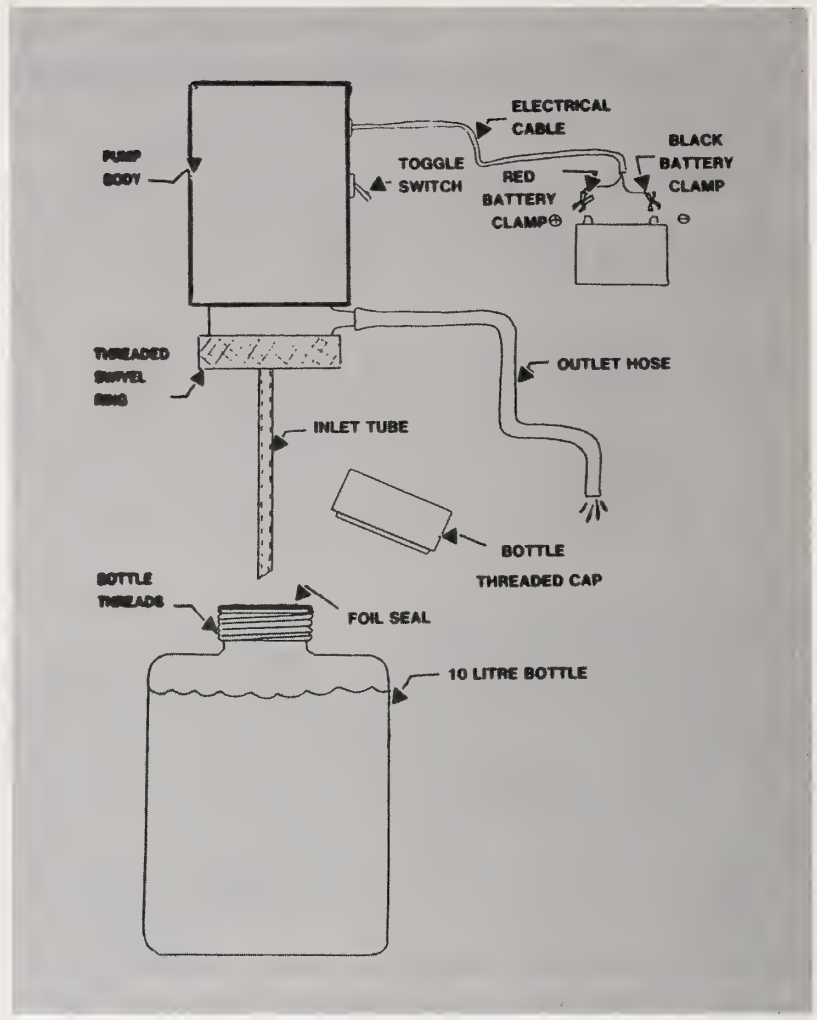
Drip applicator

Somewhat more accurate liquid seed treatment dispensers utilize an electric pump or compressed air to dispense the product onto the seed. Some units are manufactured to fit right onto the product container while others provide holding tanks for the product.

These pressurized applicators can be used in the yard while loading with an auger or mounted on the side of a truck box and used with a drill-fill.

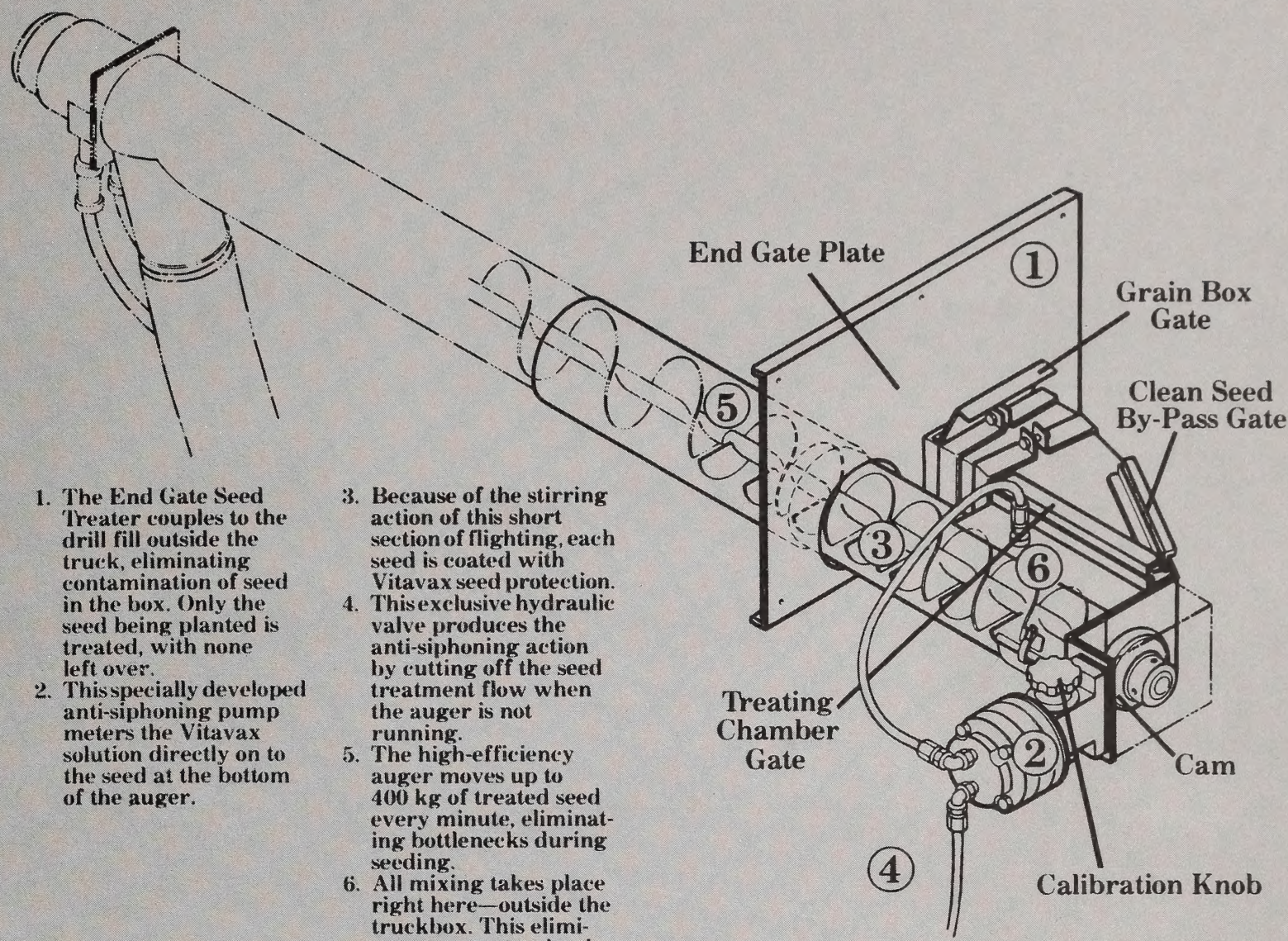
Best results are obtained when a hopper is used at the bottom of the auger and the seed is poured into the hopper. The outlet hose is attached to the hopper so that product pours into the auger at the safety cage. Best mixing occurs when the auger is running one-half to two-thirds of capacity.

Larger capacity applicators have more versatility than smaller seed treatment product dispensers. With optional attachments it's possible to apply two or more formulations simultaneously regardless of whether they are fungicides, insecticides, flowables, slurries, powders or solutions.



Pressure applicator

On-farm seed treater



1. The End Gate Seed Treater couples to the drill fill outside the truck, eliminating contamination of seed in the box. Only the seed being planted is treated, with none left over.
2. This specially developed anti-siphoning pump meters the Vitavax solution directly on to the seed at the bottom of the auger.
3. Because of the stirring action of this short section of flighting, each seed is coated with Vitavax seed protection.
4. This exclusive hydraulic valve produces the anti-siphoning action by cutting off the seed treatment flow when the auger is not running.
5. The high-efficiency auger moves up to 400 kg of treated seed every minute, eliminating bottlenecks during seeding.
6. All mixing takes place right here—outside the truckbox. This eliminates any contamination of seed.

End gate seed treater